MASTER DEVELOPMENT DRAINAGE PLAN FOR STERLING RANCH

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Project #09-002

SF-17-024

project number added

runoff determination. The rational method will be used in future reports to ensure drainage structures are of adequate size to accept anticipated peak flows, and to be consistent with the future Final Drainage Reports for multiple filings within Sterling Ranch.

a statement has been added to include preliminary identification of channel improvements

DRAINAGE FACILITIES

For the purposes of this document, being an MDDP analysis, minor pipes in the roadways have not been sized and considered for this study. Allowances have been made in the individual basin runoff parameters to account for such runoff, however it has not been routed herein. During the final design analysis phase in the future, this shall be accounted for in a detailed manner with sizes being identified. Similarly, pipe sizes and design information within each development "pod" have not been provided, but will be during the final design analysis phase in the future.

HYDROLOGIC CRITERIA

What about channel improvements?

The historic and developed drainage conditions in this report were calculated using the Soil Conservation Service (SCS) Hydrograph procedure per the El Paso County Drainage Criteria Manual. Since the majority of the drainage basins in this report exceed 100 acres in size, this method was selected for an "MDDP" level of detail. This method was also chosen to provide a comparative analysis of the pre and post development drainage flows. However, in future phases of drainage analysis for Sterling Ranch, the Rational Method will be used to analyze smaller drainage basin areas. Normally, the Rational Method is a bit more conservative, but is better used to analyze smaller basins and smaller "local" drainage facilities. The SCS procedure will be used for regional and larger drainage facilities, such as, detention ponds, channel improvements and culverts.

A short summary of the primary contributing factors for revising the hydrologic analysis include but are not limited to:

- Relocation of Marksheffel Road crossing Sand Creek from the assumed DBPS location.
- Increases in the size of upstream contributing watershed from the DBPS assumptions.
- Altering planned discharge points such as DBPS Segment 159.
- Change in the DCM criteria requiring the use of Type II storm distribution vs. Type IIA
- Minor changes in the DCM criteria, such as CN values for developments less than 2 acres
- Changes in DCM criteria implementing Offline Full Spectrum Detention in lieu of Multi Stage Online Detention Facilities.
- Desire to convert analysis from HEC-1 modeling to more recent HEC-HMS modeling software.

why?

Previous Studies

Various master plan drainage studies and construction plans have been prepared around the development and have been considered in the collection of data for this study, they include:

- Sand Creek Drainage Basin Planning Study, Kiowa Engineering, 1996.
- Master Development Drainage Plan for Woodmen Heights Master Plan, CCES, 2004
- Master Development Drainage Plan Update for Woodmen Heights and Final Drainage Report for Forest Meadows Filing No. 1 and No.4, M&S Civil Consultants, 2006
- Creek Ranch DBPS, Volume 1, Final Report, Drexel, Barrell & Co, 2007
- Sterling Ranch Sketch Plan, M&S Civil Consultants, 2008
- Master Development Drainage Plan for The Woodmen Heights Commercial Center, Matrix 2009.
- Master Development Drainage Plan and Final Drainage Report for Shiloh Mesa & Shiloh Mesa Filing No. l, M&S Civil Consultants, 2015
- Preliminary Drainage Report for Sterling Ranch - Phase I, 2016
- Sterling Ranch Filing No. 1 - Final Drainage Report, 2016
- Preliminary Bridge Design, Marksheffel Road at Sand Creek, Kiowa 2014
- Woodmen Heights Business Park, M&S Civil Consultants, 2014
- Shiloh Mesa Filing No. 1 - Marksheffel Interim Roadway Plans, M&S Civil Consultants, 2015

This document served as a comparison study for evaluation of the prepared hydrology as it differs from the SC DBPS. the reference was removed from the list but the important portions of the report still remain in the appendix.

typically a roughness factor of 0.050 was assumed for channels assuming a narrow grass lined channel with mild to steep earthen side slopes, while a roughness value of 0.013 was utilized in modeling concrete lined conveyance structures and pipes. Labeling of the channel reaches within this HMS model have been designated by RT-X and are shown on the model schematics and on the existing and proposed conditions maps included in Section A the attachments.

Tables 6-9 and 6-10 have been provided in the appendix for reference.

Runoff Curve Numbers/Impervious Percentage

The curve numbers for the existing and proposed condition watersheds within the models have been assigned based upon the land use and soil type. When multiple land uses and or soil types were encountered within a basin, an area weighted composite curve number for each sub-basin was calculated. Spreadsheets are included in Sections C and D of the attachments which provide information regarding curve number information used within the models. It should be noted that the impervious values were not included in the models as this variable was considered when choosing a CN value. One of the spreadsheets (which immediately follows the basin schematic) summarizes the various curve numbers and impervious percentage values for given land use and soil type taken directly from the drainage criteria manual. The other spreadsheets provided calculate composite impervious percent and composite curve numbers for each existing and proposed basin. It should be noted, for the future developed condition, Type A soils where represented as Type B soils in the selection of curve numbers.

Provide Tables 6-9 and 6-10

Initial Abstraction

In accordance with the City of Colorado Springs and El Paso County Drainage Criteria Manual, Initial Abstraction (IA) was calculated for each sub-basin using equation 6-12, Ia = 0.1 {(100/CN)-10]. The calculated values where input into the existing and future conditions HEC-HMS models. A table summarizing existing and future condition initial abstraction values is included attachments.

Design Rainfall

it is not advised to combine Atlas 14 and Type II SCS storm see attached letter, and discussion with City of C/S

The 24-hr storm events for the 2, 5, 10, 25, 50, and 100-year recurrence intervals were evaluated. Rainfall depths were selected using the NOAA Atlas 2 isopluvial maps provided within the DCM. Rainfall amount for representative storm events were determined to be 2.1 inches for the 2-year event, 2.5 inches for the 5-year event, 3.0 inches for the 10-year event, 3.6 inches for the 25-year event, 4.1 inches for the 50-year event and 4.6 inches for the 100-year event. The 24-Hr Type II Storm with an Antecedent Moisture Condition (AMC) of II was selected in hydrologic modeling for long duration "frontal storms".

Use NOAA values for this area: 1.95, 2.47, 2.97, 3.75, 4.42 and 5.15.

Other Design Storms

In accordance with the drainage criteria manual, a short duration, intense thunderstorms should be considered when conducting watershed drainage analysis. Typically, these smaller more intense storms create high runoff rates in smaller basins, and thus are typically not applicable for this large of watershed. A two- hour storm distribution was developed using the one-hour precipitation rates provided in the DCM and input into the HEC-HMS models. Results from the models were found to have a considerably smaller peak runoff rates and volumes and therefore were not included in this analysis to forgo any misinterpretation in the reported flow rates. .

Existing Conditions Model

Address pre-development conditions in general.

A section has been added to the report that discusses the pre-development conditions

The existing condition model analyzes 27 sub-basins totaling 3313.7 acres that are within the Sand Creek Watershed, and 6 basins totaling 872.7acres that contribute to the East Fork of Sand Creek. The basin delineation is primarily based upon the assumptions of the 2010 Draft Sterling Ranch MDDP, previously prepared by M&S Civil Consultants. Minor changes include subdividing the top of the watershed to align more closely with the proposed condition analysis, the Wilson Study and SCDBPS to provide improved direct comparisons. Additional delineation was performed outh of Sterling Ranch to include all of the area thought drain though to drain to the Sand Creek Channel above Pond 3. This delineation was done using the contours provided from the relatively recent 2003 and 2006 aerial surveys. Areas considered developed in the existing condition are visible on the aerial map (see attachments). Some of these areas include the Barbarick, Highland Park, Pawnee Rancheros and Wild Ridge Subdivisions as well as several 5-acre developments within the Black Forest area. Basin areas within the existing

model were calculated using AutoCAD. A schematic of the existing condition HEC-HMS model and the existing conditions composite CN & impervious % table showing the assumptions for all the sub-basins is included in Section C of the attachments.

3613 or 3313?

corrected acreage

Future Conditions Model

The future condition model analyze35 sub-basins totaling 3613.7 acres that are within the Sand Creek Watershed, and 14 basins totaling 690.9acres that contribute to the East Fork of Sand Creek. The future condition sub-basin were delineated using the drainage patterns assumptions brought forth from various master plans, including the draft 2010 Sterling Ranch MDDP and approved Sterling Ranch Sketch Plan. In general, developed runoff produced in the basin is to be conveyed in both natural and manmade channel, storm drainage facilities and directed to the main branch of Sand Creek and to existing swales located within the East Fork of Sand Creek Watershed. Where future development is anticipated, full spectrum water quality detention facilities are planned to reduce developed runoff rates prior to being discharged to downstream facilities. Much of the drainage infrastructure, conveyance assumptions, and the overall contributing area north of the Sterling Ranch property boundary remain the same, as previously modeled within the 2011 Wilson Study, with the exception of some minor basin boundary changes to accommodate various potential Full Spectrum Detention ponds. A schematic of the future condition HEC-HMS model and several hydrologic summary tables are included in Section D (of the attachments) which summarize the other assumptions utilized in the assembly of the model. Copies of the Existing Conditions Drainage Map and Proposed Condition Map have been included in Section B of the attachments. A copy of the 2011 Wilson Study Drainage Map and several other supporting documents have also been included in Section E of the attachments for reference. It should be noted that the increase in the watershed size, including the diversion of runoff from the East Fork Sand Creek Basin to the Upper Sand Creek Basin were previously addressed in the 2011 Wilson Study.

Address Holiday Hills.

Methodology to Implementation of Full Spectrum Detention into a Master Plan Model

To better control the full range of runoff rates that pass thru detention facilities and subsequently further reduce impacts caused by the urbanized runoff to the existing drainage ways, both the City of Colorado Springs and El Paso County have opted to move away from typical regional online detention with multi- stage discharge and have embraced the concept of offline Full Spectrum Detention. These types of facilities are constructed to release flow in a manner that more closely represents the undeveloped condition hydrograph over a extended period of time (typically up to 72 hours).

please see response letter

A master planning level procedure was needed to allow the modeler to implement FSD ponds into the model so that the effects of lag and subsequent changes in proposed flow rates could be analyzed across the watershed despite the considerable variation in the existing and proposed basin layouts. Thereby meeting the goals of the project, but not with exhaustive fine grading and modeling that is not necessary for this level of the study.

Initially, it was anticipated that the UD-FSD_v1.12 worksheet, downloaded from the Urban Drainage and Flood Control District (UDFCD) website, could be utilized to aid in providing both stage-storage and stage-discharge curves which are needed as input data for ponds within HEC-HMS. The initial design tab within the UDFCD's excel worksheet allows the user to input several watershed and anticipated detention basin parameters as well as 1-hr rainfall depths and using embedded macros the worksheet will create both inflow and outflow hydrographs which meets the required discharges rates. Unfortunately, inflow hydrographs produced by the worksheets (using the City of Colorado Springs recommended one-hour precipitation rates) were considerably smaller than the hydrographs developed within HEC-HMS using the NRCS method and recommended 24-hr precipitation values. This rendered the pond stage-storage and storage-discharge relationships ineffective for transfer in to the modeling software.

The UDFCD worksheets were still utilized but to a smaller extent, primarily to determine the allowable release rates for the contributing watersheds. By entering the contributing watershed size, slope, length of flow, and percentage of the predevelopment soil types into each spreadsheet an allowable discharge rate was calculated for each sub-basin. These values are highlighted by a red box on UD-FSD worksheets located in Section D of the attachments.

Several pond footprints were then created using AutoCAD and stage storage relationships were created for each basin and the allowable discharge rates determined by the worksheets were set as the discharge rates in the stage discharge tables in the model. The depths and volumes were then iterated for each storm event until the HEC-HMS

EXISTING BASIN DESCRIPTIONS

Existing Sand Creek (Main Stem) Basin Flows

Basin EX-82 (Q5 = 33.2 cfs, Q100 = 132.3 cfs) is a 117.8 acre area of primarily undeveloped, pine forested, land located north of Sterling Ranch and Burgess Road to the east Basin 81. Runoff from the basin continues south overland into Basin EX-74.

Basin EX-74 (Q5 = 36.5 cfs, Q100 = 140.7 cfs) is a 119.7 acre area of 5 and 10-acre lots covered with a mixture of native prairie grasses and pine trees land located north of Sterling Ranch and south of Burgess Road to the east and north of Basins 73 and 75. Runoff from Basins EX-82 and EX-74 combine at DP-74 (Q5 = 65.3 cfs, Q100 = 262.8 cfs).

Basin EX-73 (Q5 = 26.4 cfs, Q100 = 102.0 cfs) is a 90.0 acre area of 5 to 40 acres lots covered with a mixture of native prairie grasses and pine trees land located north of Sterling Ranch to the northeast of Vollmer Road. Runoff from the basin continues overland toward DP-75.

Basin EX-81 (Q5 = 70.2 cfs, Q100 = 275.7 cfs) is a 262.9 acre area of primarily undeveloped, pine forested, land located north of Sterling Ranch (approx 1 mile) between Shoup and Burgess Roads to the east of Vollmer Road. Runoff from the basin continues overland south into Basin EX-75.

Basin EX-75 (Q5 = 21.5 cfs, Q100 = 82.8 cfs) is a 79.3 acre area of pine forested lots ranging in size from 2.5 to 10 acres located north of Sterling Ranch and south of Burgess Road to the east of Vollmer Road. Runoff from the basin continues to DP-75.

Basin EX-80 (Q5 = 44.3 cfs, Q100 = 171.4cfs) is a 147.7 acre area of pine forested lots ranging in size from 2.5 to 10 acres located north of Burgess Road and to the east of Vollmer Road. Runoff from the basin continues south into Basin EX-76.

Basin EX-76 (Q5 = 23.1 cfs, Q100 = 89.6 cfs) is a 86.4 acre area consisting primarily of pine forested 2.5 acre lots located to the south of Burgess Road east of Vollmer Road. Runoff from the basin combines with flows from Basin 82, 81, 80, 75, 74, and 73 at DP-75 (Q5 = 235.1 cfs, Q100 = 950.5 cfs).

Basin EX-79 (Q5 = 57.0 cfs, Q100 = 220.1 cfs) is a 189.0 acre area of pine forested 5 to 40acre lots located , land located north of Burgess Road to the east Basin 80. Runoff from the basin continues south overland into Basin EX-78.

Basin EX-78 (Q5 = 45.3 cfs, Q100 = 174.5 cfs) is a 155.6 acre area of 2.5-acre lots covered with a mixture of native prairie grasses and pine trees land located south of Burgess Road to the east of Basins 76. Runoff from Basins 79 and 78 combine at DP-78 (Q5 = 98.4 cfs, Q100 = 385.3 cfs).

Basin EX-77 (Q5 = 56.9 cfs, Q100 = 227.7 cfs) is a 230.6 acre area of large 30+-acre lots and portions of undeveloped lands (both inside and outside of Sterling Ranch) covered with a mixture of native prairie grasses and pine trees land located east of Vollmer Road. Runoff from the basin and from DP 78 are collected and conveyed south with the Main Branch of Sand Creek toward DP -73

Basin EX-88 (Q5 = 36.7 cfs, Q100 = 144.4 cfs) is a 139.2 acre area of large 30+-acre lots and portions of undeveloped lands covered with a mixture of native prairie grasses and sparse pine trees to the north of Sterling Ranch. Runoff from DP 75 and 78 and Basins EX-77 and 78 combine within the Sand Creek Channel at DP-73 (Q5 = 388.9 cfs, Q100 = 1582.3 cfs).

corrected 381

Basin EX-6 (Q5 = 25.5 cfs, Q100 = 100.5cfs) is a 90.2 acre area of undeveloped land covered by native prairie grasses located along the northern boundary of Sterling Ranch, which is tributary to the Sand Creek channel. Runoff from Basin EX-6 is combines with flows from DP-73 in Sand Creek culminating in peak runoff rates of Q5 = 388.9 cfs, Q100 = 1637.9 at DP-71.

Basin EX-5 (Q5 = 40.0 cfs, Q100 = 158.2 cfs) is a 153.9 acre area of undeveloped lands (both inside and outside of Sterling Ranch) covered with native prairie grasses located to the south and east of Vollmer Road, including a portion

of the Sand Creek channel. Runoff from the basin generally travels from north to south until it reaches the Sand Creek Channel. Runoff from Basin EX5 combines with flows from DP71 at DP 69 culminating in peak runoff rates of Q5 = 434.8 cfs, Q100 = 1870.4

Basin EX-4 (Q5 = 49.9 cfs, Q100 = 197.3 cfs) is a 192.0 acre area located to the north and west of Sterling Ranch and Vollmer Road. In the existing condition the land is a mixture of lots ranging from 5 to 50 acres in size. Ground cover consists primarily of native grasses with scattered pine trees located within the northernmost portions of the basin. Runoff from the basin generally travels from north to south/southeast to culvert located at Vollmer Road. Flows utilizing the culvert and those exceeding its capacity are directed into Basin EX-4A and ultimately the Sand Creek Channel.

Basin EX-4A (Q5 = 40.8 cfs, Q100 = 160.1 cfs) is a 151.5 acre area of primarily undeveloped lands within Sterling Ranch that is covered with native prairie grasses located between Vollmer Road and the south boundary . A portion of the basin includes a segment of the Sand Creek channel as well as a small portion of land on the east side of the channel that had been previously utilized as a gravel pit. Runoff from the basin is directed to the Sand Creek Channel where it combines with runoff from Basin EX-3 and DP 69 culminating in peak runoff rates of Q5 = 430.7 cfs, Q100 = 1911.5 at DP63.

corrected update

Basin EX-24 (Q5 = 16.6 cfs, Q100 = 73.0 cfs) is a 63.1 acre area of an undeveloped land located south of Sterling Ranch adjacent to Sand Creek, north of Pond 3. Most of the ground is covered with native prairie grasses. Runoff from the basin combines with flows in Sand Creek Channel from DP-63 at DP 60A totaling Q5 = 544.4 cfs, Q100 = 2084.4 cfs.

Basin EX-3 (Q5 = 36.4 cfs, Q100 = 143.1 cfs) is a 136.8 acre area located to the north and west of Sterling Ranch and Vollmer Road. In the existing condition the land is a mixture of developed and undeveloped lots ranging from 5 to 90 acres in size. Ground cover consists primarily of native grasses with scattered pine trees located within the northernmost portions of the basin. Runoff from the basin generally travels from north to south/southeast to culvert located at Vollmer Road. Flows utilizing the culvert and those exceeding its capacity are directed into Basin EX-3A.

Basin EX-3A (Q5 = 47.4 cfs, Q100 = 192.6 cfs) consists of 188.1 acres located to the south and east of Vollmer Road. The basin, in its existing condition, includes an offsite commercial /industrial development known as the Barbarick Subdivision, undeveloped portions of Sterling Ranch, as well as a small offsite strip of undeveloped 5.0 acre residential lot residential at the southeastern corner of the basin. With exception of the Barbrick development the remaining land is covered with native prairie grasses. Runoff from up-gradient Basin EX-3 and those produced form within the basin travel overland to the southern boundary of the site and DP-10 culminating to produce runoff totaling Q5 = 56.0 cfs and Q100 = 287.2.

Basin EX-25 (Q5 = 1.5 cfs, Q100 = 25.1 cfs) is a 25.7 acre area of an undeveloped land located south of Sterling Ranch adjacent to Sand Creek, north of Pond 3. Most of the ground is covered with native prairie grasses. Runoff from the basin is conveyed as surface flow to channel. Runoff from the Basin combines with flows from DP-10 and DP-60A at DP -53(Q5 = 454.0 cfs, Q100 = 2061.5 cfs) at Pond 3.

Basin EX-20 (Q5 = 42.1 cfs, Q100 = 166.2 cfs) consists of 143.4 acres located to the west of Basin EX-3
In the existing condition the land is a mixture of developed and undeveloped lots ranging from 5 to 90 acres in size. Ground cover consists primarily of native grasses. Runoff from the basin is conveyed as surface flows to Basin EX-20A.

Basin EX-20A (Q5 = 51.9 cfs, Q100 = 194.6 cfs) consists of 179.7 acres located to northwest of Vollmer Road and south of Basin EX20. The basin is mostly developed consisting largely of 2.5 and 5.0 acre lots. Runoff from Basin 20 and 20A combine within the existing roadside ditches and natural drainageways within the development before combining within the roadside swale located along the west side of Vollmer Road and DP-9 totaling Q5 = 88.8 cfs and Q100 = 351.4 cfs.

Basin EX-21 (Q5 = 13.5 cfs, Q100 = 49.0 cfs) consists of 33.3 acres located north and west of Vollmer Road and south and west of Basin EX-20A. In the existing condition the land is a mixture of developed and undeveloped 2.5 acre lots, where undeveloped ground cover consists primarily of native grasses. Runoff from the basin is conveyed as surface

This basin extends from the south boundary, south, approximately 1200 linear feet from Basin EX-10 and 10A combine at southern boundary of Sterling Ranch at DP-8 (Q5 = 45.1 cfs, Q100 = 220.9 cfs),, conveyed in a few small swales within the Banning Lewis Ranch property. The flows are conveyed to the East Fork of Sand Creek, starting north of Woodmen Road. (See SCDBPS, Segments, 84 & 85, pages EF-34. The anticipated SCDBPS flow is Q10 = 478cfs, Q100 = 790cfs [Seg. 84], Q10 = 322cfs, Q100 = 533cfs [Seg. 85])

DEVELOPED DRAINAGE CHARACTERISTICS

General

A brief description of each drainage basin including historic and developed runoff rates, drainage patterns as well as existing and proposed drainage facilities for each basin is provided in this section of the report. A table of peak developed runoff for the basins and designated design points are depicted on the Proposed Conditions Drainage Map in the appendix. The total off-site discharge of flows will not exceed Historic or Sand Creek Drainage Basin Planning Study rates. A table has been provided later in this report to provide the comparison of these flows.

Drainage Basin Descriptions

Future Sand Creek (Main Stem) Basin Flows

Basin SC3-82 (Q5 = 40.6 cfs, Q100 = 156.6cfs) which is located north of Sterling Ranch and Burgess Road to the east Basin 8, assumes that the 117.8 acre area has been developed into pine forested 5-acre residential lots.. In this developed condition runoff from the basin will be directed to a proposed full spectrum detention facility (FSD 82) located at the south central portion of the basin, just to the north of Burgess Road. Released flows from the pond will continue south overland into Basin SC-74 at peak flow rates of 13.2 cfs and 130.2 cfs in the 5 and 100 year events respectively, which is less than the anticipated existing modeled flow rates of Q5 = 33.2 cfs, Q100 = 132.3cfs.

Basin SC3-74 (Q5 = 36.5 cfs, Q100 = 140.7cfs) is a 119.7 acre area of 5 and 10-acre lots covered with a mixture of native prairie grasses and pine trees land located north of Sterling Ranch and south of Burgess Road to the east and north of Basins 73 and 75. Runoff from Basins EX-74 and FSD82, combine at DP-74 (Q5 = 36.5cfs, Q100 = 249.7cfs), which is slightly less than the anticipated existing modeled flow rates of Q5 = 65.3 cfs, Q100 = 262.8 cfs.

Basin SC3-73 (Q5 = 26.4 cfs, Q100 = 102.0 cfs) is a 90.0 acre area of 5 to 40 acres lots covered with a mixture of native prairie grasses and pine trees land located north of Sterling Ranch to the northeast of Vollmer Road. Runoff from the basin continues overland toward DP-75.

Basin SC3-81 (Q5 = 78.3 cfs, Q100 = 303.4 cfs) which is located north of Sterling Ranch (approx 1 mile) between Shoup and Burgess Roads, assumes that the 262.9 acre area has been developed into pine forested 5-acre residential lots. In this developed condition runoff from the basin will be directed to a proposed full spectrum detention facility (FSD 81) located at the south basin boundary just to the north of Burgess Road. Released flows from the pond will continue south overland into Basin SC-75 at peak flow rates of 36.0 cfs and 290.9 cfs in the 5 and 100 year events respectively, which is similar to the anticipated existing modeled flow rates of Q5 = 70.2 cfs, Q100 = 275.7 cfs.

Basin SC3-75 (Q5 = 22.1 cfs, Q100 = 84.9 cfs) is a 79.3 acre area of pine forested lots ranging in size from 2.5 to 10 acres located north of Sterling Ranch and south of Burgess Road to the east of Vollmer Road. Runoff from the basin continues to DP-75.

Basin SC3-80 (Q5 = 44.3 cfs, Q100 = 171.4cfs) is a 147.7 acre area of pine forested lots ranging in size from 2.5 to 10 acres located north of Burgess Road and to the east of Vollmer Road. Runoff from the basin continues south into Basin SC-76.

Basin SC3-76 (Q5 = 23.1 cfs, Q100 = 89.6 cfs) is a 86.4 acre area consisting primarily of pine forested 2.5 acre lots located to the south of Burgess Road east of Vollmer Road. Runoff from the basin combines with flows from Basin 82, 81, 80, 75, 74, and 73 at DP-75 (Q5 = 139.5 cfs, Q100 = 928.7 cfs). Which is less than the anticipated existing modeled flow rates of Q5 = 235.1 cfs, Q100 = 950.5 cfs

no revision required to model

Revise all flows based on modeling revisions.

Note: review 1 did not include cross-checking developed flows narrative.

Basin SC3-79 (Q5 = 57.0 cfs, Q100 = 220.1 cfs) is a 189.0 acre area of pine forested 5 to 40acre lots located , land located north of Burgess Road to the east Basin 80. Runoff from the basin continues south overland into Basin SC3-78.

Basin SC3-78 (Q5 = 45.3 cfs, Q100 = 174.5 cfs) is a 155.6 acre area of 2.5-acre lots covered with a mixture of native prairie grasses and pine trees land located south of Burgess Road to the east of Basins 76. Runoff from Basins 79 and 78 combine at DP-78 (Q5 = 98.4 cfs, Q100 = 385.3 cfs). Which is equivalent to the anticipated existing modeled flow rates of Q5 = 98.4 cfs, Q100 = 385.3 cfs)

Basin SC3-77 (Q5 = 53.4 cfs, Q100 = 202.4 cfs) is located to the east of Vollmer Road and north of Arroya Lane, In the developed condition it is assumed that the majority of the 262.9 acre area will be developed into 5-acre residential lots. For the purposes of the study, runoff from the basin is assumed to be directed to a proposed full spectrum detention facility (FSD 77) located at the south basin boundary just to the north of Sterling Ranch. Released flows from the pond will at peak flow rates of 23.5 cfs and 186.7 cfs in the 5 and 100 year events respectively prior to reaching DP-77

Basin SC3-88 (Q5 = 29.4 cfs, Q100 = 113.9 cfs) is located to the east of Basin SC3-77and south of SC3-73.
In the developed condition, it is assumed that this area will be developed into 5 or less acre residential lots. Runoff produced from within the basin shall be directed to a proposed full spectrum detention facility (FSD88).located at the southeast corner of the basin. Released flows from the pond will at peak flow rates of 9.2 cfs and 99.3 cfs in the 5 and 100 year events respectively prior to reaching DP-77 Runoff from DP75, DP78, and FSD Ponds 77 and 88 combine at DP-77 at peak flow rates of 231.4cfs and 1486.8cfs in the 5 and 100 year events respectively. Runoff from DP77 continues south within the Sand Creek Channel.

Basin SC3-20 (Q5 = 19.9 cfs, Q100 = 73.5cfs) is a 50.3 acres offsite area located to the east of Vollmer Road near the northern boundary of Sterling Ranch. In the developed condition, it is assumed that this area will be developed into 5 or less acre residential lots. Runoff produced from within the basin shall be directed to a proposed full spectrum detention facility (FSD20).located at the southeast corner of the basin upstream of DP-73. Released flows from the pond will discharge into Sand Creek at peak flow rates of 8.4 cfs and 63.8 cfs in the 5 and 100 year events respectively just upstream of DP-77

Basin SC3-21 (Q5 = 25.5 cfs, Q100 = 100.5cfs) is 62.6 acres of land located both within and outside of Sterling. Ranch (near the northern boundary). For the purposes of this study, it is assumed that the offsite area will be developed into 5 acre lots, prior to the development of the 2.5-5.0 acres lost within Sterling Ranch and that all flows will be conveyed to a single offsite FSD pond (FSD21) prior to discharge runoff to the Sand Creek Channel. The treated detained flows from the pond will discharge into Sand Creek at peak flow rates of 8.8 cfs and 77.5 cfs in the 5 and 100 year events respectively just upstream of DP-77. In the event that Sterling Ranch develops prior to the adjacent offsite property then an FSD pond will be recommended for construction within the Boundary of Sterling Ranch and flows will be discharged at or below historic rates to the downstream parcel. Easements may be needed to accomplish this. Runoff from DP 77 and FSD 20 and 21combine within the Sand Creek Channel at DP-73 totaling peak flow rates of 388.9 cfs and 1582.3 cfs in the 5 and 100 year events respectively. Runoff from DP73 continues south within the Sand Creek Channel toward DP72.

Basin SC3-22 (Q5 = 14.9 cfs, Q100 = 56.5cfs) is a 40.6 acres offsite area located to the east of Vollmer Road near the northern boundary of Sterling Ranch. In the developed condition, it is assumed that this area will be developed into 5 or less acre residential lots. Runoff produced from within the basin shall be directed to a proposed full spectrum detention facility (FSD22).located at the southeast corner of the basin upstream of DP-72. Released flows from the pond will discharge into Sand Creek at peak flow rates of 8.4 cfs and 63.8 cfs in the 5 and 100 year events respectively.
The combined runoff within Sand Creek at DP 72 (from DP 73 and FDS 22) totals Q5 =236.2 cfs, Q100 = 1501.6 cfs.

Basin SC3-23 (Q5 = 31.2 cfs, Q100 = 116.2 cfs) is 81.3 acres of land located both within and outside of Sterling. Ranch (near the northern boundary). For the purposes of this study, it is assumed that the offsite area will be developed into 5 acre lots, prior to the development of the 1.0-2.5 acres lost within Sterling Ranch and that all flows will be conveyed to a single offsite FSD pond (FSD23) prior to discharge runoff to the Sand Creek Channel. The treated detained flows from the pond will discharge into Sand Creek at peak flow rates of 13.1 cfs and 100.1 cfs in the 5 and 100 year events respectively just upstream of DP-72. In the event that Sterling Ranch develops prior to the adjacent offsite property then an FSD pond will be recommended for construction within the Boundary of Sterling Ranch and flows will be discharged at or below historic rates to the downstream parcel. Easements may be needed to accomplish this. Runoff from DP 72

Have met with CCES and have included TimberRidge Zoning and Design.

Address TimberRidge zoning and design.

Sterling. Ranch, near the south boundary of the site, west of the Sand Creek Channel. This portion of Sterling Ranch is planned for a commercial site and single family residential lots ranging in size from 0.2 to 0.3 acres lots as well as portions of major and local collector roadways. A small segment of the existing Pawnee Rancheros subdivision (5 acres lots) also falls within the basin. Where not sheet flowing into the creek, the developed runoff from the basin shall be conveyed within street sections and storm sewer systems and directed to FSD Pond 6. Runoff from DP64 and from Basins SC3-6B and 6C will combine FSD6. The treated detained flows from the pond will discharge into Sand Creek at peak flow rates of 8.6 cfs and 151.6 cfs in the 5 and 100 year events respectively.

Basin SC3-8 (Q5 = 45.5 cfs, Q100 = 173.8 cfs) consists of 143.4 acres located outside of Sterling Ranch and to the west of Basin SC3-15. In the developed condition, it is assumed that the remaining large parcel are fully developed into 5 acres lots. Runoff from the basin is conveyed as surface flows to Basin SC3-9.

Basin SC3-9 (Q5 = 51.9 cfs, Q100 = 194.6 cfs) consists of 179.7 acres located to northwest of Vollmer Road and south of Basin SC3-8. In the developed condition, it is assumed that the remaining large parcel are fully developed into 5 acres lots and that Vollmer Road is widened. Runoff from Basin 20 and 20A combine within the roadside ditches and natural drainageways within the development before combining within an upgraded roadside swale located along the west side of Vollmer Road which discharges into a full spectrum detention pond (FSD9) located and the south end of the basin. The treated detained flows from the pond are conveyed under Vollmer and along Marksheffel Road within a storm drain or stabilized channel to Sand Creek at peak flow rates of 9.0 cfs and 103.1 cfs in the 5 and 100 year events respectively just upstream of DP-61.

Basin SC3-10 (Q5 = 12.3 cfs, Q100 = 47.7 cfs) consists of 36.0 acres (located outside of Sterling Ranch), of the existing Pawnee Rancheros Filing No 2 (5 acre lots), that is located to the east of Basin SC3-6. Runoff from the basin is conveyed as surface drainage to the Sand Creek Channel, where it combines with flows discharged from FSD Ponds 6 and 9 from DP 63 at the County/City Boundary (DP-61) at peak flow rates of 206.3 cfs and 1955.5 cfs in the 5 and 100 year events respectively. It is anticipated that easement from the owner of the property located to the south of the Sterling Ranch will be required to outfall the storm sewer from FSD6 as well as provide a emergency overflow route.

Basin SC3-5A (Q5 = 53.7 cfs, Q100 = 129.1 cfs) is a 39.1 acres offsite area located to the south of Sterling Ranch, east of the Sand Creek Channel. In the developed condition, it is assumed that this area will be developed into 0.12 acre residential lots, portions of Marksheffel Road and stabilized segments of the Sand Creek Channel. Runoff produced from within the basin shall be directed to a proposed full spectrum detention facility (FSD5).located at the southeast corner of the basin upstream of DP-60A. Released flows from the pond will discharge into Sand Creek at peak flow rates of 1.4 cfs and 30.1 cfs in the 5 and 100 year events.

Basin SC3-61 (Q5 = 22.0 cfs, Q100 = 84.8 cfs) is a 65.5 acres offsite area located to the south of Sterling Ranch east of Basin SC3-5B, that is made up of 5 acre lots. With the development of filing SC3-5B, a storm sewer bypass line will be constructed to safely convey the upstream runoff thru the development to the channel

Basin SC3-5B (Q5 = 73.0 cfs, Q100 = 187.0 cfs) is a 63.0 acres offsite area located to the south of Sterling Ranch east of Basin SC3-5A. In the developed condition, it is assumed that the majority of the area will be subdivided into 0.12 acre residential lots. Water quality treatment only is anticipated for this area and thus a FSD pond has not been included in the modeling. Runoff produced from within the basin shall be directed to Sand Creek.

The runoff from DP6, FSD pond 5 and Basin SC3-61 combine at DP60A at peak flow rates of Q5 = 212.4 cfs, Q100 = 2001.4, which is less than the anticipated existing modeled flow rates of Q5 = 430.2 cfs, Q100 = 191.5 at DP60A.

Basin SC3-1A (Q5 = 73.0 cfs, Q100 = 187.0 cfs) is a 63.0 acres offsite area located to the south of Sterling Ranch east of Basin SC3-5A. In the developed condition, it is assumed that the majority of the area will be subdivided open space and school grounds. Runoff produced from within the basin shall be directed to a proposed full spectrum detention facility (FSD1).located at the southeast corner of the basin upstream of DP-53A and Pond 3. Released flows from the pond will discharge into Sand Creek at peak flow rates of 1.7 cfs and 25.5 cfs in the 5 and 100 year events.
The runoff from DP60A, and FSD pond 1combine at DP53A at peak flow rates of Q5 = 212.4 cfs, Q100 = 2001.4, which is less than the anticipated existing modeled flow rates of Q5 = 430.2 cfs, Q100 = 191.5 at DP60A.

Is the City okay with this?

Yes, shiloh mesa was approved

facility (FSD-E4) located at the southeastern southeast corner of the basin. After treatment and detention, the final release rates anticipated from Basin SCE-7 and FSD Pond E4 will total Q5=2.8 cfs Q100=43.6 cfs.

Basin SCE-8 (Q5=48.4 cfs, Q100=99.9 cfs) is 25.5 acres of land located to the east of Basin SC3-7 and south of Briargate Parkway. The area is to be developed into commercial property and Banning Lewis Parkway. Runoff from the basin is to be collected within local storm sewer system and conveyed to a proposed full spectrum detention facility (FSD-E5) located at the southeastern corner of the commercial site. After treatment and detention, the final release rates anticipated from Basin SCE-8 and FSD Pond E5 will total Q5=0.2 cfs Q100=10.0 cfs.

Basin SCE-9 (Q5=2.4 cfs, Q100=8.5 cfs), consists of a 4.0 acre strip of land located along the eastern boundary of Sterling Ranch which has been dedicated for use as an open space buffer. It is anticipated in addition to a trail system the buffer zone will house a series of small storm sewer system and a trunk main which will collect and convey runoff from the adjacent basins. The discharge from DP3E, FSD Ponds 4E and 5E and Basin SCE-9 will combine within a box culvert storm sewer that parallels Banning Lewis Parkway. The peak flows at DP4E are anticipated to reach 77.4 cfs and 538.8 cfs in the 5 and 100 year events respectively. The proposed storm sewer system and collected runoff will continue south within the buffer zone.

Basin SCE-10 (Q5=189.4 cfs, Q100=467.5 cfs) is 174.3 acres of land located within the southeastern corner of Sterling Ranch. The area is to be developed into residential lots typically ranging between 3-5 dwelling units per acre. In addition to the various local roadways, and a park site, a 10 acre elementary school site is also planned for construction within this area of Sterling Ranch. Runoff produced by the basin is to be collected within local roadways and storm sewer system and conveyed to a proposed full spectrum detention facility (FSD-E6) located at the southeastern corner of the basin. After treatment and detention, the final release rates anticipated from Basin SCE-10 and FSD Pond E6 will total Q5=0.9 cfs Q100=123.3 cfs.

Basin SCE-11 (Q5=3.6 cfs, Q100=12.8 cfs), consists of a 5.8 acre strip of land located along the eastern boundary of Sterling Ranch which has been dedicated for use as an open space buffer. It is anticipated in addition to a trail system the buffer zone will house a series of small storm sewer system and a trunk main which will collect and convey runoff from the adjacent basins. The discharge from DP4E, FSD Ponds 6E and Basin SCE-11 will combine within a box culvert storm sewer that conveys runoff to DP-56. The peak flows at DP56 are anticipated to reach 76.0 cfs and 548.7 cfs in the 5 and 100 year events respectively.

Basin SCE-12 (Q5 = 5.1 cfs, Q100 = 33.3 cfs) is a 39.5 acre area of land located off-site, southeast of Sterling Ranch. This basin extends from the south boundary, south, approximately 1200 linear feet from Basin SCE-10. Runoff from the basin combines with flows from DP56 at DP-8 totaling Q5 = 81.1 cfs, Q100 = 582.0 cfs. This is higher than the existing flow rates calculated by M&S for the existing condition (Q5 = 45.1 cfs, Q100 = 220.9 cfs) but is less than that determined by the DBPS of Q100 = 533cfs [Seg. 85], or the future flows determined in the DBPS for Seg. 84 (EF-8) of 530cfs (10 year) and 980cfs (100 year). Stabilization of downstream reach(es) to accommodate developed runoff from Sterling Ranch is dependant up the timing of the construction for the downstream development and the extension of Future Banning Lewis Parkway. In the event that Sterling Ranch developed before downstream properties, it shall need be restricted to historic flows, or coordinate on downstream improvements that are needed to discharge up the lmits set within the current DPBS of 980 cfs.

South & East Boundary Discharge

The discharge of developed drainage flows from Sterling Ranch shall not adversely affect any adjacent property. The developed flows will be mitigated by the use of full spectrum detention. In no circumstance will the developed flows from Sterling Ranch exceed the Sand Creek Drainage Basin Planning Study flow amounts, or historic flows as analyzed in this report. However, at the time of final design and development layouts for these proposed areas, some discharge of flow shall be released into the existing drainage swales to the south or east, but shall not exceed the historic amount of flow. If more than the historic flow amount is proposed to be discharged, the downstream facilities shall be analyzed, designed and constructed in order to discharge more than the historic amount. Drainage easements shall also be utilized and obtained to discharge these flows onto the property east or south of Sterling Ranch.

Expand on this (see comment letter).

Please refer to comment response letter and revised report

INTERBASIN TRANSFER EAST FORK SAND CREEK TO MAIN STEM SAND CREEK

It should be noted that the proposed development plan for the ~1444 acre of Sterling Ranch redistributes a small percentage of the historic watershed between the Sand Creek and East Fork of Sand Creek watershed.

Prior to development approximately 776 acres of Sterling Ranch runoff was collected by the Sand Creek watershed with the remaining 668 acres was directed to the East Fork of Sand Creek.

After development approximately 170 acres will be redirected from the East Fork Sand Creek into the Sand Creek Basin, resulting in 946 acres of Sterling Ranch directed to the Sand Creek Basin.

This modification is driven primarily by maximizing the area of land that can be delivered to the sanitary sewer lift station. It should be noted that the East Fork of Sand Creek is still tributary to the Main Branch of Sand Creek and thus this transfer is between minor watersheds, not major watershed, and that the development as planned will still function to limit discharged runoff into Sand Creek and East Tributary to the historic flow rates.

Model Results

The following tables summarizes the modeled existing and future conditions peak discharge rates at Design Points located near the subject reach and specific locations for analysis. The flow rates are reported for the 2, 5, 10, 25, 50, and 100-year storm events. Where applicable comparison were made to the Wilson Study and the SCDBPS, refer to the Existing and Future Hydrologic Condition Maps for a complete listing of the Basin, Design Points, and Water Quality and Detention Pond flow rate and storage summaries.

DP77 added to table

2018 HEC HMS Models, 2011 Wilson HEC-1 Model and 1996 DPBS Flow Rate Comparisons

Summary of Peak Discharges						
Design Point 69 - Future Briargate Parkway X-ing						
Storm Event (YR)	2	5	10	25	50	100
2018 Existing Cond. (cfs)	253	435	708	1,100	1,453	1,870
2018 Future Cond. (cfs)	134	257	499	864	1,263	1,673
Design Point 68 - Future Sterling Ranch Road X-ing						
Storm Event (YR)	2	5	10	25	50	100
2018 Existing Cond. (cfs)	n/c	n/c	n/c	n/c	n/c	n/c
2018 Future Cond. w/o Pnd (cfs)	132	255	580	1,064	1,598	2,152
2018 Future w/Pnd (cfs)	105	203	463	914	1,303	1,653
Design Point 63 - Southern Bndry Sterling Ranch Development						
Storm Event (YR)	2	5	10	25	50	100
2018 Existing Cond. (cfs)	251	431	713	1,113	1,496	1,912
2018 Future Cond. w/o Pnd (cfs)	129	255	587	1,087	1,625	2,177
2018 Future w/Pnd (cfs)	105	203	472	933	1,327	1,696
2011 Wilson (cfs)			1,066			1,791
1996 DBPS Existing Cond. (cfs)						2,508
1996 DBPS Developed Cond. (cfs)						2,514

Design Point 61 - City/County Boundary						
Storm Event (YR)	2	5	10	25	50	100
2018 Existing Cond. (cfs)	n/c	n/c	n/c	n/c	n/c	n/c
2018 Future Cond. w/o Pnd (cfs)	126	257	650	1,239	1,871	2,517
2018 Future w/Pnd (cfs)	107	206	531	1,051	1,523	1,956
2011 Wilson (cfs)			1,232			2,087

Add DP 77 - Arroya Lane

Design Point 60A - Future Marksheffel Xing						
Storm Event (YR)	2	5	10	25	50	100
2018 Existing Cond. (cfs)	248	430	707	1,112	1,497	1,913
2018 Future Cond. w/o Pnd (cfs)	127	261	661	1,265	1,910	2,566
2018 Future w/Pnd (cfs)	111	212	543	1,074	1,559	2,001
2011 Wilson (cfs)			1,265			2,133
1996 DBPS Existing Cond. (cfs)						2,629
1996 DBPS Developed Cond. (cfs)						3,225
Design Point 53A Sand Creek Pond 3 Drop Structure						
Storm Event (YR)	2	5	10	25	50	100
2018 Existing Cond. (cfs)	262	454	763	1,197	1,610	2,062
2018 Future Cond. w/o Pnd (cfs)	122	260	659	1,267	1,918	2,574
2018 Future w/Pnd (cfs)	110	212	546	1,078	1,568	2,017

n/c - not calculated

why is detail on this facility necessary? the size is considerably smaller than what was previously proposed (in previous submittals) so there is no concern regarding not having enough land, is further detailing required?

(Pond W3) Provide a section addressing this pond in detail.

It should be noted that after the initial run of the Proposed Condition Model, it was determined that the peak developed 100-year flow reaching the subject reach were slightly higher than the 100-year existing condition flow rates and higher than the 100-year peak flows anticipated by the Wilson Study. To reduce the runoff, an online detention facility has been added to the model upstream of Sterling Ranch Road within the Sterling Ranch Development. The incorporation of this facility when coupled with multiple Full Spectrum Detention facilities will allow the development upstream of the City/County boundary to release developed discharge at a rate this is at or below the current existing flow rates. It should be noted that the location of the facility was previously planned as a regional pond /park site in the Sterling Ranch 2010 MDDP (Draft) and Sketch Plan. Stage storage and stage volume worksheets are included in the attachments.

Design point 61 is located on the maps between Sand Creek Regional Detention Pond 3 and south boundary of Sterling Ranch just upstream of Mustang Road. Future development in the watershed should attempt to mimic the flow rates provided within the report with special consideration given to the flow at the City/County boundary line at Design Point 61. It should be noted that the hydrologic calculations contained in this memorandum are intended to aid in the design of the crossing structure at Marksheffel Road north of Pond 3 (DP 60A) and as a planning resource to limit the amount of developed runoff discharged into the Sand Creek Channel. This report is not intended to be utilized for final design of stormwater storage facilities and infrastructure.

Reasonableness of Models

Based upon an analysis of the results, both the existing conditions and proposed condition models appear to produce reasonable flow rates. Peak flow rates as a whole are down slightly from those produced by both the previous Wilson model and previous DBPS models, which seem reasonable given the revised models incorporation of lower CN values (which are attributed to rural developments and undeveloped properties) and the DCM recommendation to utilized the Type II storm distribution in lieu of the previously modeled Type IIA distribution. It should be noted that a comparison table has been included in the appendix which provides a direct comparison of the runoff of each individual developed basin using both the Type II and type IIA storm. Based upon the summarized data there is an approximate average decrease in runoff of 16% when the Type II storm in the 100-year event using a rainfall of 4.6" inches.

As the nearest functioning stream gage for the watershed is located several miles downstream near Sand Creek Regional Detention Pond No. 1, two additional methodologies and an secondary (other than Sand Creek) published watershed study were analyzed to further evaluate the flow rates computed by the prepared HEC-HMS model.

Provide current FEMA flows and address need for LOMR to revise hydrology.

Regression Equations

The first regression formula used as a comparison was taken from "The Analysis of the Magnitude and Frequency of Floods in Colorado," published in 2000 by the United State Geological Survey. A copy of a page from the

we will add a section to discuss the current FEMA flows and need to revise the hydrology for the purposes of CLOMR/LOMR hydrology

update per other comments

This is now a reference from the sand creek channel study

Add proposed interim model (no offsite upstream development or detention). Add "emergency conditions" analysis results.

Provide current FEMA flows.

publication containing the equation has been included in the appendix of the report. The 100 year equation which represents "Plains Regions" within the State of Colorado is as follows.

the future model has been removed from this analysis, as such the iterim model is simply just the developed condition.

100- Year Storm Q = 1,640 * (Drainage Area) $^{0.388}$

The second regression formula evaluated was taken from the "Guidelines for Determining 100 year Flood Flows for Approximate Floodplains in Colorado." Version 6.0 published in 2004 by the US Colorado Water Conservations Board. The Northern Foothill Sub-Region equation was selected from the publication. This sub-region includes streams which are tributary to and east of the Monument Creek and Fountain Creek (downstream of Monument Creek) mainstems. These tributary streams originate from the Black Forest/Palmer Divide area, the northeast portion of Colorado Springs, and the Black Squirrel Creek basin east of Colorado Springs. A copy of a page from the publication containing the equation has been included in the appendix of the report. The 100- year equation which represents "Northern Foothills Sub-Region " within the State of Colorado is as follows.

100- Year Storm Q = 1,343.4 * (Drainage Area) $^{0.578}$

Current FEMA flows added to table

The table below summarizes the comparison of the peak 100 year flow rates developed by the various model and regression equations, additional discussion of the results follows.

			2018 M&S Civil Exist Cond. Model		2018 M&S Civil Prop. Cond. Model	1996 DBPS Exist Cond. Model		USGS Re-gression Equation			CWCB Re-gression Equation		
Design	Acc..	Acc.		CFS						%			
Point	Area	Area	Q100	per	Q100	Q100	% Diff		% Diff	% Diff		% Diff	Diff
ID	(sq mi)	(sq mi)	(CFS)	Acre	(CFS)	(CFS)	Exist.	(CFS)	Exist.	Prop.	(CFS)	Exist.	Prop..
DP-73	2.52	1,613	1,582.3	0.98	1,522			2,347	148%	154%	2,292	145%	151%
DP-71	2.669	1,708	1,637.9	0.96	1,523			2,400	147%	158%	2,369	145%	156%
DP-69	3.209	2,054	1,870.4	0.91	1,673			2,578	138%	154%	2,636	141%	158%
DP-63*	3.446	2,205	1,911.5	0.87	2,177	2,508	131%	2,650	139%	122%	2,746	144%	126%
DP-60A*	3.545	2,269	1,913.5	0.84	2,566	2,629	137%	2,680	140%	104%	2,792	146%	109%
DP-53A*	4.138	2,648	2,061.5	0.78	2,574			2,845	138%	111%	3,053	148%	119%

*2018 M&S Proposed Condition Model flow rates provided are without the detention facility PNDW3 above DP68 (this model has not been included in the appendix of this study)

For the 100 year return period, the USGS regression equation varied from 138% higher to 148% higher than M&S study computed existing flows and 104% to 158% higher than the proposed modeled flows. The variability to the modeled flow rates can be attributed to the following factors:

1) The equation is based on a limited number of gaging stations in the eastern plains, none of which are in the watershed or immediate general vicinity (the closest being Franktown Colorado).

2) The regression equations have a margin of error of 41% to 300% and thus may not be reliable. The study identified the plains region possessing the largest average standard errors of prediction.

3) The regression equations include only that the drainage area be utilized as a factor in determining a flow rates and do not take into account rainfall, basin shape, slope, soil type or vegetative cover.

The regression equation provided by the CWCB's Guidelines for Determining 100-Year Flood Flows for Approximate Floodplains in Colorado, varied from 141% higher to 148% higher than M&S study computed existing flows and 109% to 158% higher than the proposed modeled flows. The variability to the modeled flow rates can be attributed to the following factors:

1) The provided regression equation was developed using previous floodplain studies, not gaged data. It is unclear if

Add pre-development flow (UDFCD based on soil type or model)

pre-development model added.

any of the studies utilized are adjacent to the subject area, what physical characteristics of the studied watersheds were and what rainfall or storm distributions were utilized in the studies.

2) The study identified the Northern Foothills region possessing the largest average standard errors of prediction.

3) The regression equations include only that the drainage area be utilized as a factor in determining a flow rates and do not take into account rainfall, basin shape, slope, soil type or vegetative cover.

Other Basin Study

In addition to comparing to the regression equations provided above, the "Gieck Ranch Drainage Basin Planning Study," published in 2007, by Drexel, Barrell & Company, was also utilized as a comparison tool. The existing watershed which is located to the north and east of the City of Falcon possesses similar drainage characteristics to that of the existing evaluated watershed. A comparison of the two studied basin characteristic is as follows:

Existing Basin Condition Comparison												
	Basin Size	Basin Size	Basin Length	Upper Elev	Lower Elev	Dom. Soil	Veg. Cover	Dom. Basin	CN Value	% Imp	100 Yr Flow	Runoff/ Acre
Sterling Ranch MDDP	(Sq Mi)	(AC)	(Mi)	(Ft)	(Ft)	Types	Cond.	Slopes			(cfs)	(cfs/ac)
Upper Sand Creek	4.1	2,648	6.1	7,620	6,890	A&B	Fair-Good	1.0-8.0%	63	7	1,914	0.7
Gieck Ranch Basin												
Main Channel at Elbert Road	3.0	1,928	n/p	7,300	n/p	A&B	Fair	n/p	66	< 1	1,010	0.5
Confluence of East Fork & Main Channel	5.5	3,504	n/p	7,300	n/p	A&B	Fair	n/p	67	< 1	1,817	0.5
Gieck Ranch Basin (Overall)	22.05	1,4111	15.0	7,300	6,100	A&B	Fair	0.5-5.0%	66	< 1	4,326	0.3

n/p = not provided

Sand Creek Channel Study analyzed a Type II Storm Distribution

Gieck Ranch Basin analyzed a Type IIA Storm Distribution

For the 100 year return period, the Gieck Ranch Basin produced discharge between 0.3 and 0.5 cfs per acres in comparison to the subject basin's 0.7 cfs/acre. The variability to the modeled flow rates can be attributed to the following factors.

1) The Gieck Ranch Basins, as a whole, are slightly less impervious than the modeled watershed, which would typically result in a low discharge/acre.

2) The Gieck Ranch Basin Study utilizes a slightly higher CN value (66 vs 63) which would typically result in a higher discharge/acre.

3) The Gieck Ranch watershed has a slightly flatter topography (0.5-5% vs 0.5-8%) and appears to have slightly longer lag times (refer to GRDBPS existing conditions data), which would typically result in a low discharge/acre.

4) The Gieck Ranch Basin Study utilizes a Type IIA storm versus the subject analysis which utilizes a Type II Storm which would typically result in a higher discharge/acre.

Although some variability exists between the methodologies utilized between the GRDBPS and the subject study, overall, the comparison basin possesses similar geographic features and correspondingly produced similar runoff per acre values.

Conclusions regarding modeling

As discussed, both the existing conditions and proposed condition models provided by this report appear to produce reasonable results. Peak flow rates as a whole are down slightly from those produced by both the previous Wilson model and previous DBPS models, which would seem reasonable given the revised models incorporation of lower

I don't know that this is very helpful with so many variables.

Retained to justify our output values without any gage data nearby...

CN values (which are attributed to rural developments and undeveloped properties) and the DCM recommendation to utilized the Type II storm distribution in lieu of the previously modeled Type IIA distribution. The primary purposed of the study was to establish a flow rates for various portions of the Sand Creek Channel.

SAND CREEK DBPS (SCDBPS) REIMBURSABLE IMPROVEMENTS VERSUS STERLING RANCH MDDP

DBPS Segment 159, & 164 (DBPS Pages 47-48, 50A) - Western Tributary to Sand Creek Channel

The existing swale is a western Tributary of the Sand Creek. The confluence of the tributary and the main stem exists within the Woodmen Heights master plan area, south of Sterling Ranch. These two existing channel segments are proposed in the DBPS as "Improved Riprap Channel, Bottom Width 25', Depth 3', Slope 1.2%, 3' Drops @ 270' intervals, Q100=600 cfs". The two Segments are divided by "Proposed Research Parkway" (currently relocated, and known as Marksheffel Road & Research Parkway) The crossing is shown in the DPBS as; 2-6'High x 9' Wide Concrete Box Culverts. The MDDP does not propose a CBC crossing of the western tributary for Research Parkway at this location. The tributary will be crossed by Sterling Ranch Road using a ~66" RCP.

The SCDBPS does not continue the analysis northerly through the existing industrial property, which does not account for flows from the west side of Vollmer Road. This MDDP, accounts for +300 acres of property on the west side of Vollmer Road that is tributary to Segment 159 & 164. The MDDP design uses RCP to convey the existing and developed storm water to Sand Creek, in lieu of Riprap channels. Furthermore, the MDDP proposes Pond W-5, at the southeast side of Segment 159, to provide detention and water quality prior to discharge in Sand Creek. (See Detention Section of this report for more information on Pond FSD6)

DBPS Segment 163, 187, 170 & 171 (DBPS Pages 49-53) - Mainstem Sand Creek Channel

The SCDBPS for Sand Creek channel within Sterling Ranch proposes check structures, select riprap linings and grade control structures to improve the existing channel. The DPBS also states;

"Areas within the exiting floodplain or the low flow zone of the drainageway where riparian or wetland vegetation exists shall be preserved in its existing cross section. Areas disturbed by the construction of drops, grade control, culverts, or channel bank linings shall be revegetated with native species."

The SCDBPS proposes two crossings of major roadways within Sterling Ranch. The southerly one is at "Proposed Research Parkway" (currently relocated and known as Marksheffel Road & Research Parkway), which is now shown on the approved Sketch Plan for Sterling Ranch as "Sterling Ranch Road". The second major crossing is at "Proposed Banning-Lewis Parkway" (Which is now shown on the approved Sketch Plan for Sterling Ranch as "Briargate Parkway"). The southerly crossing is proposed as; 4-10' wide x 8' High Concrete Box Culverts. The northerly crossing of Brairgate Parkway is proposed as; 4-10' wide x 8' High concrete box culverts. Both these proposed crossings are shown in the SCDBPS as reimbursable bridges. A second crossing of "Research Parkway is shown on the SCDBPS east of Sand Creek along the southern boundary of Sterling Ranch (6'H x 8'W CBC). The MDDP does not propose a CBC crossing for the eastern tributary for Research Parkway at this location.

The MDDP proposes to construct the Sand Creek main stem channel improvements as suggested by the SCDBPS and per current EPC criteria. The MDDP also proposes to construct the CBC box culverts under Sterling Ranch Road and Briargate Parkway. The final design of the Sand Creek channel and crossings will determine the total number and size of structures, drops, box culverts, etc...

Additional Reimbursable improvements along the Sand Creek Channel include, as shown in the SCDBPS are; Pond Outlet Structures (Segment 170 & 163). These structures, and all others along Sand Creek will be re-analyzed in the final design stage.

DBPS Segment 186 & 169 (DBPS Pages 51-52) - Western Tributary to Sand Creek Channel

The existing swale is a western Tributary of the Sand Creek. The confluence of the tributary and the main stem exists within the Sterling Ranch master plan area. These two existing channel segments are proposed in the DBPS as "Improved Riprap Channel, Bottom Width 20', Depth 3', Slope 1.3%, 3' Drops @ 450' intervals, Q100=500 cfs" (Segment 186) and Improved Riprap Channel, Bottom Width 20', Depth 2', Slope 1.8%, 3' Drops, Q100=325

Provide bridge culvert calculations.

culvert calculations have been added to the appendix of the report

cfs" (Segment 169). The two Segments are divided by "Proposed Banning-Lewis Parkway" (currently known as Briargate Parkway) The crossing is shown in the DPBS as a; 6'High x 10' Wide Concrete Box Culverts. The MDDP does not propose a CBC crossing of Briargate Parkway at this location. The SCDBPS also shows a 60" CMP culvert across Vollmer Road at the terminus of Segment 169.

The SCDBPS does not continue the analysis northerly across Vollmer Road. This MDDP, accounts for +300 acres of property on the west side of Vollmer Road that is tributary to Segment 186 & 169. The MDDP design uses RCP to convey the existing and developed storm water to Sand Creek, in lieu of riprap channels. The flows north of Briargate Parkway (Segment 169) will be diverted along the northerly right-of-way of Briargate Parkway to Sand Creek. The flows south of Briargate Parkway (Segment 186) will be conveyed to Sand Creek through the proposed development. The MDDP proposes to install a 60" RCP culvert under Vollmer Road along with Headwalls and Wing Walls. The construction of these improvements will occur with the widening of Vollmer Road and the construction of the adjacent development at Sterling Ranch.

(Refer to MDDP for Sterling Ranch Filing Nos. 1 &2, and Final Drainage Report for Sterling Ranch Filing No. 1, approved January, 2018). Construction drawings for RCP to replace Segment 186 were approved as a part of Sterling Ranch Filing No. 1, approved, January, 2017.

DBPS Segment 92 (DBPS Page EF-34) - East Fork Tributary to Sand Creek Channel

The existing swale is a part of the Eastern Tributary of Sand Creek. The confluence of the tributary and the main stem exists several miles south of the Sterling Ranch master plan area. The existing channel segments is proposed in the DBPS as "Improved Riprap Channel, Bottom Width 15', Depth 3', select bank linings. (No other data was given) The Segment terminates at the southern boundary of Sterling Ranch at "Proposed Research Parkway", and continues southerly as Segment 84. These two Segments are divided by "Proposed Research Parkway" (currently shown on the approved Sketch Plan for Sterling Ranch as Banning-Lewis Parkway) The crossing is shown in the DPBS as a; 6'High x 10' Wide Concrete Box Culverts. The MDDP does not propose a CBC crossing of Banning-Lewis Parkway at this location.

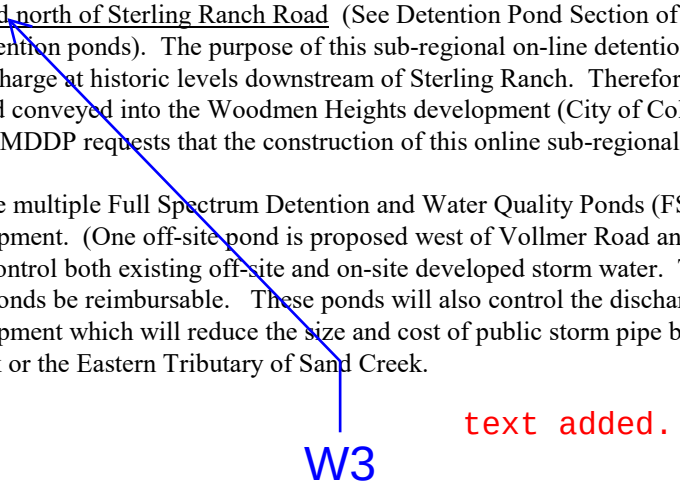
The SCDBPS (Segment 92) does not continue the analysis more than a few thousand feet north of the south boundary of Sterling Ranch. This MDDP, accounts for +1,000 acres of property north of the DBPS. The MDDP design uses RCP to convey the existing and developed storm water to the Eastern Tributary of Sand Creek, in lieu of Riprap channels. Furthermore, the MDDP proposes Pond FSD-E6, at the southeast corner of Sterling Ranch, to provide detention and water quality prior to discharge in Eastern Tributary Channel of Sand Creek. (See Detention Section of this report for more information on Pond FSD-E6).

Proposed Variations To SCDBPS For Reimbursement

The MDDP identifies regional improvements for Sterling Ranch and for existing land outside the limits of Sterling Ranch to the west, north & east. The SCDBPS limited study did not address these areas. Therefore, the MDDP requests that these regional public infrastructure components be reimbursable.

Sand Creek Regional Pond north of Sterling Ranch Road (See Detention Pond Section of this report for more information regarding detention ponds). The purpose of this sub-regional on-line detention facility is to control storm water events to discharge at historic levels downstream of Sterling Ranch. Therefore, the storm water flows exiting Sterling Ranch and conveyed into the Woodmen Heights development (City of Colorado Springs) to the south are consistent. The MDDP requests that the construction of this online sub-regional pond is reimbursable.

FSD Ponds - There will be multiple Full Spectrum Detention and Water Quality Ponds (FSD Ponds) located within the Sterling Ranch development. (One off-site pond is proposed west of Vollmer Road and north of Marksheffel Road) These ponds will control both existing off-site and on-site developed storm water. The MDDP requests that the Sterling Ranch FSD Ponds be reimbursable. These ponds will also control the discharge of storm water across the Sterling Ranch development which will reduce the size and cost of public storm pipe between the ponds and discharge into Sand Creek or the Eastern Tributary of Sand Creek.



Additional Culvert crossings of Vollmer Road - Additional culverts across Vollmer Road are required to convey the storm water from the west side to the east side. The existing Vollmer Road, and roadside swales are inadequate to covey the 100-year storm. The culverts, and improvements to Vollmer Road will drastically improve the current storm water public infrastructure. The culverts, FSD's, and downstream storm water pipe to convey these flows to Sand Creek is requested to be reimbursable. will be

Un-named easterly tributary for the Sand Creek - A second crossing of "Research Parkway is shown on the SCDBPS east of Sand Creek along the southern boundary of Sterling Ranch (6'H x 8'W CBC). The MDDP does not propose a CBC crossing for the eastern tributary for Research Parkway at this location, because Research Parkway is no longer proposed along the southern boundary of Sterling Ranch. However, the tributary for this crossing was un-studied in the SCDBPS. The MDDP for Sterling proposed storm sewer pipe and open channel to convey the developed flows into the Sand Creek Channel. The existing flows rates will be reduced, but remain present for the downstream properties. See Existing Basin section of this report. The MDDP request that this Un-named tributary be considered reimbursable.

CHANNEL IMPROVEMENTS

Per the Sand Creek DBPS, Sand Creek and connected tributaries in the area of the site will require improvements. The east and west tributary reaches within the site boundary will not require improvements because they will no longer be present, as development in the areas will eliminate them, and replace them with full spectrum detentions ponds to control the discharge into Sand Creek. The western tributary reach within the site boundary will require some improvements in some areas but will also be eliminated by development and replaced with large diameter storm sewer and Pond FSD6, to control the discharge into Sand Creek.

However, Sand Creek itself will continue to be routed through the development. Per the DBPS, selective rip rap linings, grade control check structures, and drop structure improvements are required to stabilize the channel to prevent further degradation, scour and meandering. Full Spectrum Detention will be used for its benefits to the integrity of the Sand Creek Channel.

Downstream channel improvements are proposed to be similar to what was anticipated in the SCDBPS. Check structures and rip-rap lining in some locations shall be installed to handle the increase in volume of flows from the full spectrum detention ponds. In the final design stage of development, the channels will be analyzed to verify the amount of improvements necessary.

Channel Improvements and Wetland Mitigation

Areas with the existing floodplain or the low flow zone of the drainageways where riparian or wetland vegetation exists shall be preserved in its existing cross section. Areas disturbed by the construction of drops, grade controls, culverts or channel bank linings shall be revegetated with native species. Coordination with the Army Corp of Engineers for permitting of wetland modifications shall be approved before construction commences.

WATER QUALITY PROVISIONS

Address CLOMR/LOMR requirements.

have added discussion regarding CLOMR/LOMR

General

The water quality capture volume (WQCV) required for the site has been determined based on the guidelines as set forth in the City of Colorado Springs/El Paso County Drainage Criteria Manual – Volume II. The final outlet facilities will be designed as part of the final construction drawings for the site. *Refer to the Drainage Map for locations of contributing watershed basins.* Water quality calculations have been made for the contributing watershed to each of the FSD ponds and the open channel segment at the south end of the development. The entire contributing watershed to the Sterling Ranch development will be treated on site.

We will add inflow/outflow rates and volumes have been provided on the developed maps.

Discuss inflow, outflow, volumes

REGIONAL DETENTION FACILITIES

A single regional online detention facility (Pond W3) , upstream of Sterling Ranch Road (at DP68), is recommended to aid in controlling of the total runoff leaving Sterling Ranch . Although the development of Sterling Ranch will require the implementation and construction of several FSD ponds to mitigate increase runoff, the total amount of runoff reaching the Sand Creek Channel is greater than historic, due to the inter-basin transfer of drainage from East Fork of Sand Creek Watershed to Sand Creek Watershed. The roadway embankment, proximity to the southern boundary and the need for a culvert crossing at this location make the location practical. A separate design report for this facility will needed to verify the volumetric sizing.

revised

Are you adding more?

Prior to this analysis an online regional facility was also recommended within Sterling Ranch (on the Sand Creek Channel) upstream of Briargate Parkway at DP 69. ....The planned implementation of offline full spectrum detention for the developable ground up-gradient of this location will alleviate the need for this facility. ..

Refer to comment response letter.

Address downstream City Pond 3.

Final Design Considerations

There are numerous final design considerations that must be performed prior to construction. Noteworthy considerations/issues include water quality management, and wetland mitigation. Additional items include, outfall piping, outlet structures, maintenance requirements, embankment linings, freeboard, emergency overflow weirs, jurisdictional dam structure design, development phasing, interim staging to historic flows until the downstream facilities can be constructed, etc. A jurisdictional dam analysis will be studied and confirmed with the Division of Water Resources, Dam Safety branch, Office of the State Engineer, prior to final design of any detention structure. Possible design of pond outfall structures include; small circular pipe release with CBC overflow, full spectrum release with water quality screening and micro pool, CBC with a weir release, or a combination of the aforementioned structures.

Full Spectrum Detention

Detention design alternatives will be investigated with each phase of development to reduce impacts on Sand Creek or tributary, stream degradation and storm water quality. Design of a Full Spectrum release detention pond will be compared to the phased amount of developed flows entering the proposed ponds at any given phase of development. The developed flows entering the detention ponds will increase as development occurs and therefore the detention ponds outlet structures may need to be modified for certain phases of development. At no time is the total amount of the 100 year flow to exceed the preliminary designed flow rates per the SCDBPS or exiting/historic flows. Full Spectrum detention will be considered for the ultimate design build out of this development.

The intention of full spectrum detention per "Concept Paper, Peak Flow Control for Full Spectrum of Design Storms, by Jim Wulliman and Ben Urbonas", (See Appendix) is to achieve peak flows close to pre-development conditions for the full spectrum of runoff events. Therefore, by closely matching the pre-development condition, geomorphic changes in the downstream channel is less likely. "*It is expected that degradation will occur at reduced rates and, possibly, to lesser levels if runoff volume and peak rate are kept closer to predevelopment conditions"*. Therefore, the scope of channel improvements as discussed in the next section will need to be investigated at the final design stage based upon the amount of flow during different phases of development. The proposed increase in volume downstream per the redirection of area to the east and west areas of the site, will be controlled by the FSD ponds, and should not adversely effect the downstream channels due to the 72 hour pond drain time. The proposed channel improvements in the SCDBPS are still valid, however, the timing and quantity/sizing of structures may be reduced. The final size of the Sterling Ranch FSD Ponds will have to be determined based upon the intensity of development upstream of the proposed ponds.

text added

and other offsite

Increased flows at DP8 will not work unless downstream conveyance and easements are provided to an adequate outfall. Address what is needed specifically.

STERLING RANCH DISCHARGE COMPARISONS

This has been clarified

Pre/Post Development - As analyzed by M&S Civil Consultants

Design Point /	Proposed Discharge 100-year	Existing Conditions 100-year	Comments
DP1	0 cfs	32.2 cfs	Redirected to FSD-6, Revaluate with Final Design
DP2	0 cfs	30.9 cfs	Redirected to FSD-6, Revaluate with Final Design
DP3	0 cfs	7.1 cfs	Redirected to FSD-6, Revaluate with Final Design
DP4	0 cfs	107.4 cfs	Redirected to FSD-11B, Revaluate with Final Design
DP5	0 cfs	20.5 cfs	Redirected to FSD-11B, Revaluate with Final Design
DP6	0 cfs	125.2 cfs	Redirected to FSD-E6, Revaluate with Final Design
DP7	0 cfs	277.9 cfs	Redirected to FSD-E6, Revaluate with Final Design
DP8	582.0 cfs	220.9 cfs	Less than DBPS (Seg. 85)
DP9A	0 cfs	380.5 cfs	Bypassed to SC channel below FSD-E6
DP63	1693.4cfs	1911.5 cfs	~218 cfs less than historic, Sets flow at MS X-ing @ 2000 cfs

Per the above table, in all locations along the Sand Creek Channel or tributary to the East Fork watershed, the proposed flow rates are less than the rates specified in the existing conditions or the DBPS. . Future phasing and planning of Sterling Ranch may create the need to re-evaluate discharge flows and along the southern boundary, where topographic constraints may make slightly change the contributing drainage areas in this region.

EXISTING UTILITIES – HIGH PRESSURE GAS PIPELINES

we will expand paragraph

At the southwest corner of Sterling Ranch exists three high pressure gas/petroleum pipelines. There are two 20-inch diameter and one 6-inch diameter pipelines. Special care in design and coordination with the appropriate utility agency shall be made to ensure of safety. Also, at the southwest portion of the site exists a Colorado Springs Utilities gas distribution line that serves the Barbarick Subdivision. This gas line will likely be relocated in the proposed right-of-way of the southern proposed subdivision. However, it should be noted that the gas pipelines existed pre-development. Additional utilities are present, adjacent to the Vollmer right-of-way. including...

STERLING RANCH FILING NO. 1 - SUBDIVISION IMPROVEMENTS AGREEEMENT

Sterling Ranch Filing No. 1 final plat and SIA was recorded prior to the completion of this report. The aforementioned documents outlined drainage for Sterling Ranch in the following manner;

2. ***Drainage and Landscaping Tracts****: Improvements on Tracts A, B, F, H, I, J, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, AA and CC as identified on the final plat of Filing No. 1 will be completed to the satisfaction of the County and District and, upon said completion, the improvements will be dedicated to and accepted by the District. Improvements on Tract D (Sand Creek) will be completed to the satisfaction of the County and upon said completion, the improvements will be dedicated to and accepted by the County. The ownership and maintenance of storm drain facilities and structures not located on the foregoing tracts shall be determined as follows. All storm pipe shall be owned and maintained by the District except where located in County road rights of way (see Paragraph 5 below), in which case the County shall own and maintain the storm drain facilities and structures, including but not limited to, inlets and manholes. A typical cross section describing the ownership and maintenance responsibilities of drainage improvements within County rights of way is attached as Exhibit C hereto.*

7. ***Timing of Construction and Acceptance****:*

a. ***Drainage Improvements Not Located in Sand Creek Channel****: Except as set forth below in subsection 6.b. (drainage improvements located in Sand Creek Channel), all drainage improvements described in Exhibit A and constructed within the Drainage and Landscaping Tracts identified in paragraph 2 above shall be*

completed by the Subdivider and District, meeting all applicable standards for preliminary acceptance, prior to the recording of the first replat of Tracts C, E, G, K or BB. In the event that a portion of the drainage improvements are not completed prior to the recording of the first replat, then prior to such recording collateral sufficient in the opinion of the County to assure completion of the improvements must be posted by the Subdivider and a deadline by which such drainage improvements shall be completed shall be established by written agreement.

b. ***Drainage Improvements Located in Sand Creek Channel (Tract D):*** *The District agrees that it will construct or cause the construction of all drainage improvements to be located in Tract D as well as future tracts within Sterling Ranch containing the Sand Creek Channel in accordance with the following:*

   i. *Bank stabilization of the Sand Creek channel shall be required prior to any replats or other final plats adjacent to the channel. The design and installation of said improvements shall be accomplished and guaranteed through the normal subdivision review and collateralization process.*

   ii. *Other drainage improvements in Tract D and future tracts containing the Sand Creek Channel, such as drop structures, check structures and similar stabilization or protection improvements, will be designed and constructed by the District with the final construction drawings to be approved by the County no later than the final platting of the 700th single family lot within the boundaries of the approved Sterling Ranch Sketch Plan and the completion of all said improvements no later than the 800th single family lot with the boundaries of the approved Sterling Ranch Sketch Plan.*

   iii. *In order to assure completion of the drainage improvements required in Subsection 6.b.ii above as well as a fair apportionment of the costs of said drainage improvements amongst adjacent Sterling Ranch subdividers, the District agrees to establish a Sand Creek Channel Drainage Fee to be paid into a District Escrow Fund by adjacent subdividers at the time of final platting. The amount of the fee shall be a minimum of One Thousand Dollars ($1,000.00) per single family lot. The details of the proposed Sand Creek Channel Drainage Fee and the District Escrow Fund shall be agreed to by the parties in advance of the submittal of the first replat of or subdivision of the Master Pad Sites or other property located within Sterling Ranch.*

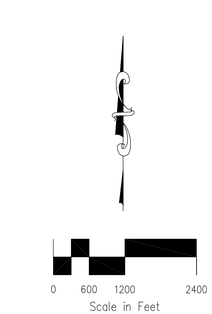
A full copy of the recorded SIA is located in the files of El Paso County and EPC Clerk and Recorders office under Reception No. 218714151

SUMMARY

Sterling Ranch contains ~1444 gross acres, not including adjacent road rights-of-way, and approximately 50 acres within the Sand Creek 100-year floodplain. The development of the site will require drainage and detention facilities to accommodate developed flows and meet El Paso County Drainage Criteria. The proposed drainage facilities will adequately convey, detain and route runoff from the site to Sand Creek or existing off-site drainage swales. All drainage facilities described herein and shown on the included drainage map are subject to change due to final design considerations. The drainage analysis has been prepared in accordance with the current City of Colorado Springs/El Paso County Drainage Criteria Manual. **The development of Sterling Ranch will not adversely affect downstream facilities or property**. Supporting information and calculations are included in the Appendix.

All onsite and offsite drainage facilities.....

Address anticipated offsite FSD facilities to the north



LEGEND

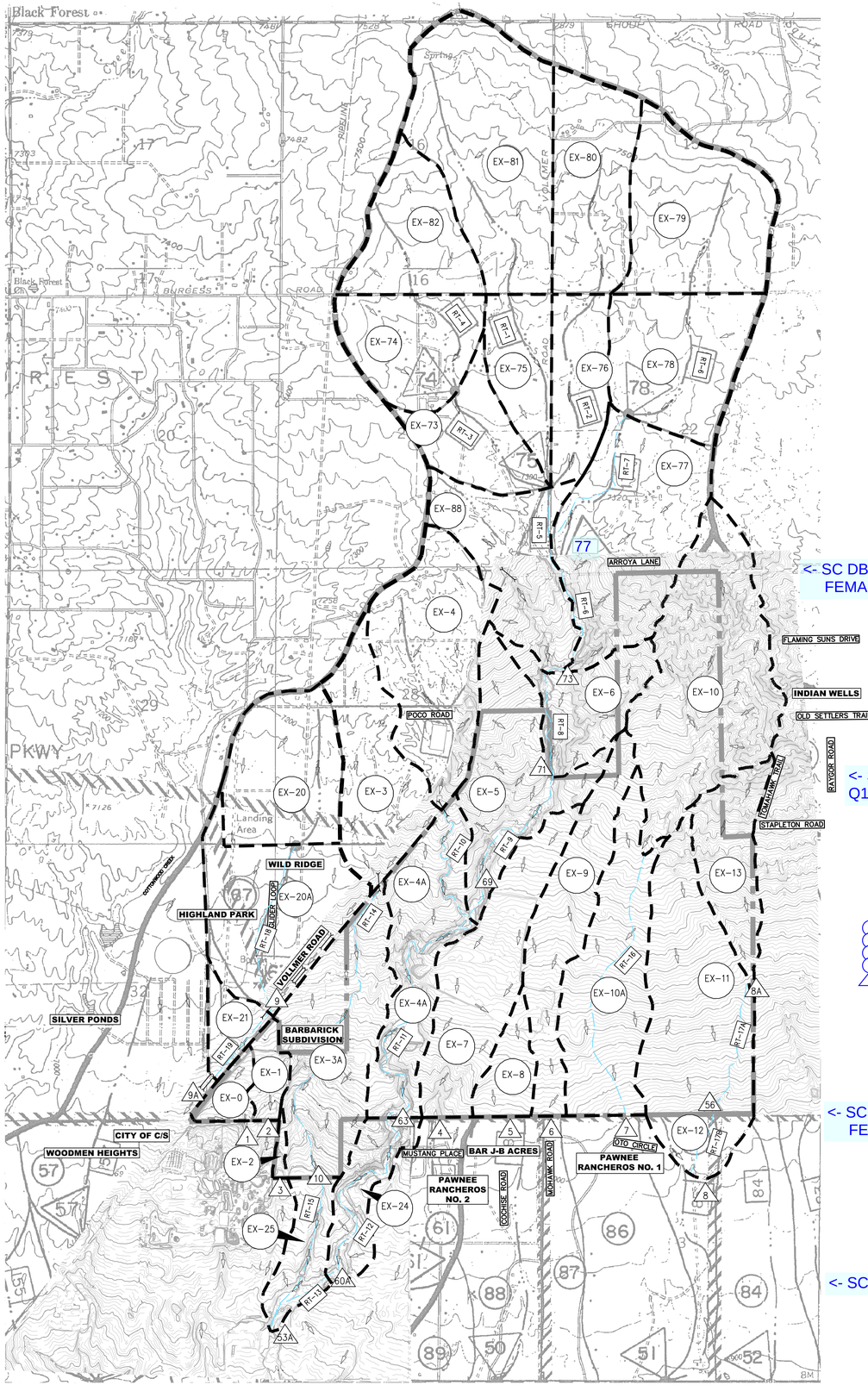
BASIN ID – SC3-77

DESIGN POINT – 87

REACH IDENTIFIER – RT-17A

BASIN BOUNDARY –

FLOW DIRECTION –



<- SC DBPS Q100 = 2,170
FEMA 2,600

<- SC DBPS Q100 = 2,260

<- SC DBPS Q100 = 2,552
FEMA 2,600

<- SC DBPS Q100 = 2,629

Show

Add DBPS areas and flows at channel DPs.

COMMENTS ON MAP HAVE BEEN ADDRESSED

BASIN SUMMARY

BASIN	CN	AREA (ACRES)	AREA (SQ MI)	Q_2 (CFS)	Q_5 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{50} (CFS)	Q_{100} (CFS)
EX-0	62	23.8	0.037	5.0	8.2	13.0	19.6	25.7	32.2
EX-1	62	25.7	0.040	4.8	7.9	12.4	18.7	24.5	30.9
EX-2	62	5.5	0.009	1.1	1.8	2.8	4.3	5.6	7.1
EX-3	62	136.8	0.214	22.0	36.4	57.6	86.9	114.0	143.1
EX-3A	61	188.1	0.294	28.3	47.4	75.7	115.1	152.2	192.6
EX-4	62	192.0	0.300	30.1	49.9	79.1	119.5	157.0	197.3
EX-4A	62	151.5	0.237	24.7	40.8	64.4	97.0	127.2	160.1
EX-5	62	153.9	0.240	24.2	40.0	63.4	95.9	125.9	158.2
EX-6	62	90.2	0.141	15.3	25.5	40.1	60.7	79.9	100.5
EX-7	56	165.0	0.258	11.6	21.5	37.5	60.9	83.1	107.4
EX-8	45	42.0	0.066	0.5	1.7	4.5	9.4	14.5	20.5
EX-9	54	131.9	0.206	12.2	23.9	43.1	70.9	97.0	125.2
EX-10	60	270.7	0.423	32.7	56.0	91.1	140.1	185.9	236.1
EX-10A	41	179.3	0.280	0.6	2.2	7.3	17.4	29.1	43.1
EX-11	43	209.3	0.327	18.0	29.8	47.7	73.4	98.3	126.1
EX-12	51	39.5	0.062	2.2	5.1	10.1	17.7	25.1	33.3
EX-13	55	89.3	0.139	7.7	15.2	27.1	44.2	60.5	78.4
EX-20	62	143.4	0.224	25.4	42.1	66.7	100.7	132.3	166.2
EX-20A	64	179.7	0.281	32.2	51.9	80.5	119.8	155.9	194.6
EX-21	65	33.3	0.052	8.6	13.5	20.7	30.5	39.4	49.0
EX-24	59	63.1	0.099	9.5	16.6	27.5	42.9	57.4	73.0
EX-25	43	54.4	0.085	0.3	1.5	4.8	10.7	17.2	25.1
EX-73	63	90.0	0.141	16.4	26.4	41.3	62.1	81.3	102.0
EX-74	63	119.7	0.187	22.3	36.5	57.3	85.9	112.3	140.7
EX-75	63	79.3	0.124	13.1	21.5	33.7	50.5	66.1	82.8
EX-76	63	86.4	0.135	14.2	23.1	36.4	54.6	71.4	89.6
EX-77	62	230.6	0.360	34.7	56.9	90.6	137.5	180.9	227.7
EX-78	63	155.6	0.243	28.1	45.3	70.6	106.2	139.1	174.5
EX-79	63	189.0	0.295	34.9	57.0	89.5	134.3	175.6	220.1
EX-80	63	147.7	0.231	27.3	44.3	69.6	104.5	136.8	171.4
EX-81	62	262.9	0.411	42.6	70.2	111.0	167.4	219.6	275.7
EX-82	62	117.8	0.184	20.0	33.2	52.8	80.0	105.1	132.3
EX-88	62	139.2	0.217	22.2	36.7	58.0	87.6	115.0	144.4

DESIGN POINT SUMMARY

DESIGN POINT	AREA (SQ MI)	Q_2 (CFS)	Q_5 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{50} (CFS)	Q_{100} (CFS)	LOCATION
DP-74	0.371	39.3	65.3	104.8	158.9	209.1	262.8	
DP-75	1.413	141.2	235.1	376.6	566.6	750.9	950.5	
DP-78	0.538	59.7	98.4	154.0	232.6	306.2	385.3	
DP-73	2.520	225.9	380.7	618.0	957.0	1260.4	1582.3	
DP-71	2.669	229.3	388.9	629.7	978.8	1277.3	1637.9	STERLING RANCH NORTHERN BNDRY
DP-69	3.209	253.0	434.8	707.7	1100.0	1453.3	1870.4	
DP-63	3.446	251.4	430.7	713.1	1113.2	1496.2	1911.5	STERLING RANCH SOUTHERN BNDRY
DP-10	0.508	36.5	56.0	106.4	162.9	220.6	287.2	COLORADO SPRINGS/EL PASO BNDRY
DP-9A	0.557	55.3	94.3	150.3	227.7	299.5	380.5	VOLLMER/TAHITI DRIVE
DP-9	0.505	52.8	88.8	142.1	214.2	281.0	351.4	VOLLMER/LOCHWINNOCH LN
DP-8A	0.139	7.7	15.2	27.1	44.2	60.5	78.4	D/S STERLING RANCH EASTERN BNDRY
DP-8	0.389	24.2	45.1	77.8	124.4	169.5	220.9	D/S STERLING RANCH SOUTHERN BNDRY
DP-7	0.703	32.4	57.1	97.3	156.1	213.8	277.9	STERLING RANCH SOUTHERN BNDRY
DP-6	0.206	12.2	23.9	43.1	70.9	97.0	125.2	STERLING RANCH SOUTHERN BNDRY
DP-5	0.066	0.5	1.7	4.5	9.4	14.5	20.5	STERLING RANCH SOUTHERN BNDRY
DP-4	0.258	11.6	21.5	37.5	60.9	83.1	107.4	STERLING RANCH SOUTHERN BNDRY
DP-3	0.009	1.1	1.8	2.8	4.3	5.6	7.1	STERLING RANCH SOUTHERN BNDRY
DP-2	0.040	4.8	7.9	12.4	18.7	24.5	30.9	STERLING RANCH SOUTHERN BNDRY
DP-1	0.037	5.0	8.2	13.0	19.6	25.7	32.2	STERLING RANCH SOUTHERN BNDRY
DP-60A	3.545	247.7	430.2	707.1	1113.0	1496.6	1913.5	FUTURE MARKSHEFFEL X-ING
DP-53A	4.138	262.1	454.0	763.2	1196.5	1609.8	2061.5	SAND CREEK AND POND 3

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20 BOULDER CRESCENT, SUITE 110
COLORADO SPRINGS, CO 80903
PHONE: 719.955.5485

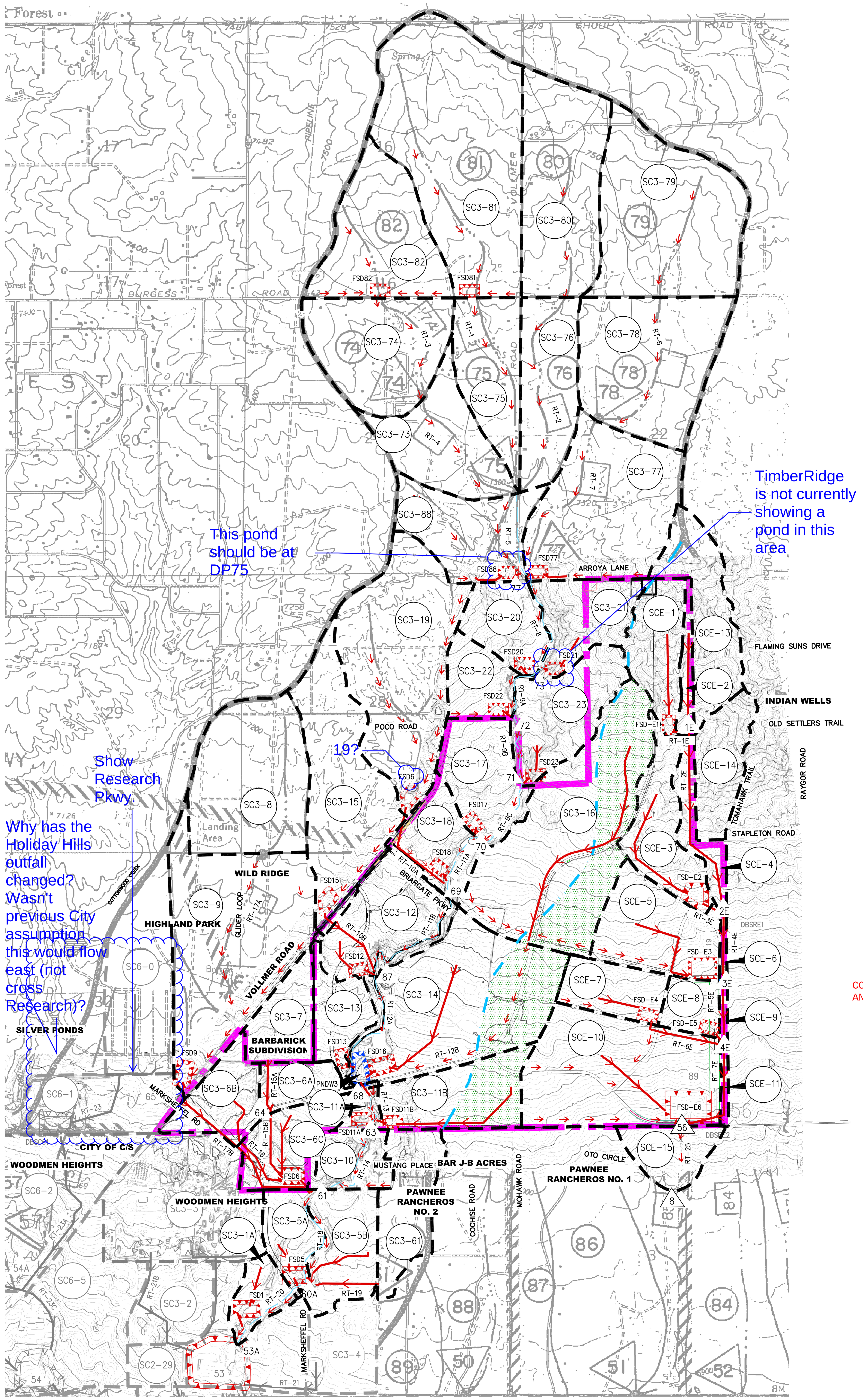
2018 STERLING RANCH MDDP

EXISTING HYDROLOGIC CONDITIONS MAP

PROJECT NO. 08-035
FILE: \dwg\Eng Exhibits\2018-MDDP-ExistCondWSWrkMap-REVISED COLORS - JD.dwg
DESIGNED BY: DLM
DRAWN BY: DLM
CHECKED BY: VAS
SCALE
HORIZ: NTS
VERT: NTS
DATE: 07-22-16

DM1

File: O:\08002A\Sterling Ranch District\dwg\Eng Exhibits\2018 MDDP\2018-MDDP-ExistCondWSWrkMap-REVISED COLORS - JD.dwg Plotstamp: 7/2/2018 4:18 PM



Revise all values per modeling calculations.

BASIN SUMMARY

BASIN	CN	AREA (ACRES)	AREA (SQ MI)	Q_2 (CFS)	Q_5 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{50} (CFS)	Q_{100} (CFS)
SC3–1A	73	27.8	0.085	31.4	45.0	63.8	88.5	110.3	133.1
SC3–5A	84	39.1	0.061	40.6	53.7	71.0	92.4	110.6	129.1
SC3–5B	81	63.0	0.098	53.8	73.0	98.5	130.8	158.6	187.0
SC3–6A	88	49.3	0.077	61.4	79.3	102.2	130.1	153.6	177.1
SC3–6B	85	30.9	0.048	32.9	43.4	57.0	73.9	88.2	102.7
SC3–6C	82	58.0	0.091	53.9	72.5	97.1	128.0	154.5	181.5
SC3–7	88	45.7	0.071	54.0	69.9	90.3	115.2	136.2	157.2
SC3–8	63	143.4	0.224	28.0	45.5	71.1	106.4	138.9	173.8
SC3–9	66	217.4	0.340	49.2	76.2	115.0	168.1	217.1	269.5
SC3–10	63	36.0	0.056	7.6	12.3	19.4	29.1	38.0	47.7
SC3–11A	70	10.7	0.017	5.3	7.8	11.3	15.9	20.0	24.3
SC3–11B	80	76.6	0.120	59.4	81.3	110.8	148.1	180.5	213.7
SC3–12	81	88.2	0.138	77.8	105.6	142.5	189.1	229.1	270.0
SC3–13	85	41.0	0.064	43.9	57.8	76.0	98.5	117.6	136.9
SC3–14	80	199.4	0.311	162.1	221.4	300.7	401.5	488.6	577.7
SC3–15	65	147.6	0.231	32.8	51.8	79.4	117.0	151.5	188.3
SC3–16	79	224.1	0.350	150.7	208.5	286.6	386.6	473.7	563.4
SC3–17	71	70.6	0.110	37.2	53.9	77.7	109.9	138.8	169.2
SC3–18	81	53.7	0.084	49.3	67.1	91.0	121.2	147.3	174.0
SC3–19	63	191.5	0.299	37.2	60.5	94.6	141.6	184.9	231.4
SC3–20	63	50.3	0.079	12.2	19.6	30.4	45.2	58.9	73.5
SC3–21	63	62.6	0.098	14.3	23.1	36.1	53.9	70.3	87.9
SC3–22	63	40.6	0.063	9.2	14.9	23.2	34.6	45.2	56.5
SC3–23	64	81.3	0.127	19.5	31.2	48.2	71.6	93.0	116.0
SC3–61	63	65.5	0.102	13.7	22.0	34.4	51.6	67.6	84.8
SC3–73	63	90.0	0.141	16.4	26.4	41.3	62.1	81.3	102.0
SC3–74	63	119.7	0.187	22.3	36.5	57.3	85.9	112.3	140.7
SC3–75	63	79.3	0.124	13.6	22.1	34.6	51.9	67.8	84.9
SC3–76	63	86.4	0.135	14.2	23.1	36.4	54.6	71.4	89.6
SC3–77	63	163.8	0.256	33.0	53.4	83.2	124.1	161.9	202.4
SC3–78	63	155.6	0.243	28.1	45.3	70.6	106.2	139.1	174.5
SC3–79	63	189.0	0.295	34.9	57.0	89.5	134.3	175.6	220.1
SC3–80	63	147.7	0.231	27.3	44.3	69.6	104.5	136.8	171.4
SC3–81	63	262.9	0.411	48.3	78.3	123.1	184.9	242.0	303.4
SC3–82	63	117.8	0.184	25.0	40.6	63.7	95.5	125.0	156.6
SC3–88	63	87.2	0.136	18.3	29.4	46.2	69.4	90.9	113.9
SCE–1	65	64.4	0.101	23.3	35.9	53.8	79.1	102.4	127.4
SCE–2	64	15.0	0.023	4.4	7.0	10.8	15.9	20.7	25.7
SCE–3	70	67.5	0.105	30.6	45.2	65.9	93.3	118.0	143.9
SCE–4	70	29.5	0.046	13.3	19.6	28.6	40.6	257.8	62.6
SCE–5	87	85.5	0.134	100.4	130.6	169.6	217.4	257.8	298.4
SCE–6	64	3.8	0.006	1.6	2.5	3.7	5.4	7.0	8.6
SCE–7	89	44.9	0.070	58.9	75.5	96.6	122.2	143.7	165.2
SCE–8	92	25.5	0.040	38.6	48.4	60.7	75.4	87.7	99.9
SCE–9	64	4.0	0.006	1.5	2.4	3.6	5.3	6.8	8.5
SCE–10	83	174.3	0.272	7.6	189.4	19.4	29.1	398.9	467.5
SCE–11	64	5.8	0.009	2.3	3.6	5.5	8.0	10.3	12.8
SCE–13	63	78.6	0.123	19.6	31.3	48.7	73.1	95.7	120.0
SCE–14	63	52.5	0.082	13.2	21.2	33.3	49.9	65.2	81.7
SCE–15	51	39.7	0.062	2.2	5.1	10.1	17.7	25.1	33.4

Include lower basins in the model if you're running it to Pond 3

Don't assume attenuation effects of offsite ponds

DESIGN POINT SUMMARY

DESIGN POINT	AREA (SQ MI)	Q_2 (CFS)	Q_5 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{50} (CFS)	Q_{100} (CFS)	LOCATION
DP–74	0.371	22.3	36.5	61.8	136.5	192.8	249.7	
DP–75	1.413	82.4	139.5	230.2	521.6	724.3	928.7	
DP–77	2.343	139.3	231.4	430.3	793.5	1118.3	1486.8	ARROYA LANE X–ING
DP–78	0.538	59.7	98.4	154.0	232.6	306.2	385.3	
DP–73	2.520	137.4	236.9	446.0	806.4	1145.0	1521.9	
DP–72	2.583	134.9	236.2	443.8	793.7	1156.5	1501.6	POCO ROAD X–ING
DP–71	2.710	135.1	242.0	452.4	803.1	1154.4	1523.3	STERLING RANCH NORTHERN BNDRY
DP–70	2.820	134.4	246.1	462.4	808.9	1177.6	1543.2	
DP–69	3.203	134.3	256.6	499.1	864.2	1262.7	1673.2	BRIARGATE PARKWAY X–ING
DP–87	3.572	133.9	255.6	541.2	922.7	1371.3	1836.4	
DP–68	4.297	105.0	202.9	462.9	914.3	1302.7	1653.2	STERILNG RANCH ROAD X–ING
DP–64	0.148	114.5	148.0	191.1	243.7	288.0	332.4	
DP–63	4.434	105.1	203.2	471.7	932.6	1327.0	1693.4	STERLING RANCH SOUTHERN BNDRY
DP–61	5.341	106.6	206.3	531.1	1051.2	1523.3	1955.5	COLORADO SPRINGS/EL PASO BNDRY
DP–60A	5.602	111.0	212.4	543.2	1073.9	1558.5	2001.4	MARKSHEFFEL X–ING
DP–53A	5.687	110.4	212.3	546.2	1078.2	1567.6	2017.3	SAND CREEK AND POND 3
DP–1E	0.247	23.9	38.3	70.1	132.8	173.0	220.9	
DP–2E	0.486	49.4	77.6	124.2	230.4	321.8	422.0	
DP–3E	0.626	49.4	76.5	123.6	272.9	389.2	502.7	
DP–4E	0.745	49.4	77.4	124.5	288.8	410.6	538.8	
DP–56	1.017	47.3	76.0	122.2	285.6	403.0	548.7	NEAR SE PROP CORNER
DP–8	1.079	49.2	79.3	129.3	289.8	418.0	561.0	BELOW SE PROP CORNER

COMMENTS ON MAP HAVE BEEN ADDRESSED
ANALYSIS NOT INTENDED TO MODEL POND 3.

WATER QUALITY & DETENTION POND SUMMARY

FSD1

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	31.4	45.0	63.8	88.5	110.3	133.1
ALLOWABLE RELEASE (CFS)	0.1	1.7	3.3	10.9	17.5	25.5
MODELED RELEASE (CFS)	0.2	1.7	3.3	10.9	17.5	25.5
STORED VOLUME (AC–FT)	2.4	2.6	3.0	3.6	4.2	4.9

FSD5

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	40.6	53.7	71.0	92.4	110.6	129.1
ALLOWABLE RELEASE (CFS)	0.1	1.4	2.6	11.3	19.8	30.2
MODELED RELEASE (CFS)	0.1	1.4	2.6	11.2	19.7	30.1
STORED VOLUME (AC–FT)	3.0	3.2	3.8	4.1	4.7	5.2

FSD6

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	196.6	258.6	339.2	438.9	523.4	608.8
ALLOWABLE RELEASE (CFS)	0.6	8.3	15.9	60.5	101.7	151.7
MODELED RELEASE (CFS)	0.6	8.3	15.9	60.4	101.4	151.6
STORED VOLUME (AC–FT)	15.4	16.1	18.3	20.6	23.2	26.2

FSD9

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	67.9	112.8	174.2	259.1	342.0	429.4
ALLOWABLE RELEASE (CFS)	1.7	24.9	49.8	141.1	207.2	290.0
MODELED RELEASE (CFS)	1.7	20.8	49.4	141.2	206.9	289.4
STORED VOLUME (AC–FT)	9.0	9.0	10.0	11.3	13.0	14.5

Add corresponding DP/general location after each pond ID.

WATER QUALITY & DETENTION POND SUMMARY

FSD11A

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	5.3	7.8	11.3	15.9	20.0	24.3
ALLOWABLE RELEASE (CFS)	0.1	1.6	3.2	7.5	9.7	12.4
MODELED RELEASE (CFS)	0.2	0.9	3.0	7.6	9.6	12.2
STORED VOLUME (AC–FT)	0.3	0.3	0.4	0.4	0.5	0.6

FSD11B

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	59.4	81.3	110.8	148.1	180.5	213.7
ALLOWABLE RELEASE (CFS)	0.3	4.5	8.7	29.6	47.7	69.6
MODELED RELEASE (CFS)	0.3	4.5	8.6	29.5	47.7	69.0
STORED VOLUME (AC–FT)	4.8	4.9	5.5	6.4	7.3	8.2

FSD12

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	77.8	105.6	142.5	189.1	229.1	270.0
ALLOWABLE RELEASE (CFS)	0.9	13.2	26.7	62.0	80.2	103.2
MODELED RELEASE (CFS)	0.9	9.0	26.7	61.9	80.1	103.1
STORED VOLUME (AC–FT)	5.2	5.5	5.8	6.7	7.8	8.9

FSD13

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	43.9	57.8	76.0	98.5	117.6	136.9
ALLOWABLE RELEASE (CFS)	0.4	6.1	12.3	28.6	37.0	47.6
MODELED RELEASE (CFS)	0.4	4.2	12.3	28.6	36.9	47.2
STORED VOLUME (AC–FT)	3.1	3.1	3.3	3.8	4.4	5.0

FSD15

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	32.8	51.8	79.4	117.0	151.5	188.3
ALLOWABLE RELEASE (CFS)	1.2	17.5	35.7	85.4	111.7	145.8
MODELED RELEASE (CFS)	1.2	13.1	35.7	85.4	111.7	145.7
STORED VOLUME (AC–FT)	3.3	3.3	3.6	4.0	4.5	5.0

FSD16

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	248.6	362.6	503.9	692.0	852.3	1016.5
ALLOWABLE RELEASE (CFS)	1.5	21.5	41.9	143.4	231.0	338.7
MODELED RELEASE (CFS)	1.5	21.5	41.8	143.2	230.8	338.7
STORED VOLUME (AC–FT)	25.5	26.0	29.7	34.2	39.0	43.9

FSD17

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	37.2	53.9	77.7	109.9	138.8	169.2
ALLOWABLE RELEASE (CFS)	0.7	11.1	22.5	52.0	67.2	86.3
MODELED RELEASE (CFS)	0.7	7.3	22.4	52.0	67.3	86.3
STORED VOLUME (AC–FT)	2.3	2.3	2.5	3.0	3.6	4.2

FSD18

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	49.3	67.1	91.0	121.2	147.3	174.0
ALLOWABLE RELEASE (CFS)	0.6	9.2	18.4	42.2	54.6	69.9
MODELED RELEASE (CFS)	0.6	6.6	18.4	42.2	54.6	69.6
STORED VOLUME (AC–FT)	3.2	3.2	3.4	4.0	4.7	5.3

FSD19

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	37.2	60.5	94.6	141.6	184.9	231.4
ALLOWABLE RELEASE (CFS)	1.7	24.6	50.3	118.4	153.3	198.4
MODELED RELEASE (CFS)	1.7	18.6	50.3	118.1	153.2	198.2
STORED VOLUME (AC–FT)	3.4	3.4	3.7	4.1	4.5	5.1

FSD20

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	12.2	19.6	30.4	45.2	58.9	73.5
ALLOWABLE RELEASE (CFS)	0.6	8.4	16.8	38.8	50.1	64.2
MODELED RELEASE (CFS)	0.6	8.4	16.6	38.8	50.0	63.8
STORED VOLUME (AC–FT)	0.8	0.8	0.9	1.0	1.1	1.3

FSD21

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	14.3	23.1	36.1	53.9	70.3	87.9
ALLOWABLE RELEASE (CFS)	0.7	10.1	20.3	47.0	60.7	77.9
MODELED RELEASE (CFS)	0.7	8.8	20.3	46.9	60.6	77.5
STORED VOLUME (AC–FT)	1.0	1.0	1.1	1.2	1.4	1.5

FSD22

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	9.2	14.9	23.2	34.6	45.2	56.5
ALLOWABLE RELEASE (CFS)	0.4	6.6	13.2	30.5	39.4	50.5
MODELED RELEASE (CFS)	0.4	2.1	13.3	29.9	39.3	49.9
STORED VOLUME (AC–FT)	0.7	0.8	0.8	0.9	0.9	1.0

FSD23

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	19.5	31.2	48.2	71.6	93.0	116.0
ALLOWABLE RELEASE (CFS)	0.9	13.0	26.2	60.6	78.4	100.6
MODELED RELEASE (CFS)	0.9	13.1	26.0	60.4	78.3	100.1
STORED VOLUME (AC–FT)	1.4	1.5	1.6	1.7	1.9	2.1

FSD77

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	33.0	53.4	83.2	124.1	161.9	202.4
ALLOWABLE RELEASE (CFS)	1.6	23.7	48.1	112.2	145.1	186.9
MODELED RELEASE (CFS)	1.6	23.5	48.0	110.0	144.9	186.7
STORED VOLUME (AC–FT)	2.8	2.8	3.0	3.3	3.6	3.9

FSD81

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	48.3	78.3	123.1	184.9	242.0	303.4
ALLOWABLE RELEASE (CFS)	2.4	36.7	74.5	174.3	225.5	290.9
MODELED RELEASE (CFS)	2.4	36.0	74.5	174.3	225.3	290.9
STORED VOLUME (AC–FT)	4.6	4.7	4.9	5.2	5.5	5.9

FSD82

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	25.0	40.6	63.7	95.5	125.0	156.6
ALLOWABLE RELEASE (CFS)	1.1	16.4	33.4	78.1	101.1	130.4
MODELED RELEASE (CFS)	1.1	13.2	33.3	78.2	101.2	130.2
STORED VOLUME (AC–FT)	2.1	2.1	2.3	2.5	2.8	3.2

WATER QUALITY & DETENTION POND SUMMARY

Move to end or highlight / bold somehow.

FSD88

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	18.3	29.4	46.2	69.4	90.9	113.9
ALLOWABLE RELEASE (CFS)	0.8	12.6	25.6	59.7	77.3	99.5
MODELED RELEASE (CFS)	0.8	9.2	25.2	59.6	77.2	99.3
STORED VOLUME (AC–FT)	1.5	1.5	1.7	1.8	2.0	2.2

PNDW3

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	131.6	254.8	579.5	1064.4	1597.5	2152.4
MODELED RELEASE (CFS)	105.0	202.9	462.9	914.3	1302.7	1653.2
STORED VOLUME (AC–FT)	1.3	3.2	9.1	19.6	30.5	43.9

FSD–E1

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	9.8	26.2	44.2	76.7	100.0	127.4
ALLOWABLE RELEASE (CFS)	0.7	11.0	22.1	50.9	65.7	84.1
MODELED RELEASE (CFS)	0.7	5.4	19.9	48.9	62.8	84.0
STORED VOLUME (AC–FT)	0.6	1.5	2.9	4.7	6.3	8.1

FSD–E2

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	20.2	39.5	58.6	91.1	115.4	143.9
ALLOWABLE RELEASE (CFS)	0.6	9.5	19.2	45.5	59.8	77.6
MODELED RELEASE (CFS)	0.6	3.2	18.5	41.3	58.5	74.7
STORED VOLUME (AC–FT)	0.5	1.5	3.1	5.2	7.2	9.2

FSD–E3

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	104.2	144.8	178.1	219.9	256.9	298.4
ALLOWABLE RELEASE (CFS)	0.9	13.2	26.5	61.6	79.8	102.6
MODELED RELEASE (CFS)	1.0	6.8	25.7	56.0	79.8	101.3
STORED VOLUME (AC–FT)	0.9	3.2	6.3	10.1	13.4	16.7

FSD–E4

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	61.4	82.0	100.1	123.0	142.9	165.2
ALLOWABLE RELEASE (CFS)	0.3	4.4	8.8	23.0	32.2	43.7
MODELED RELEASE (CFS)	0.9	2.8	8.7	21.9	32.2	43.6
STORED VOLUME (AC–FT)	0.4	1.7	3.3	5.3	7.1	8.8

FSD–E5

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	43.3	55.0	65.5	76.9	87.8	99.9
ALLOWABLE RELEASE (CFS)	0.0	0.2	0.4	4.2	8.7	14.3
MODELED RELEASE (CFS)	0.0	0.2	0.5	2.2	5.1	10.0
STORED VOLUME (AC–FT)	0.0	0.1	0.3	1.3	2.3	3.4

FSD–E6

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	123.9	167.9	219.7	319.1	385.9	467.5
ALLOWABLE RELEASE (CFS)	0.2	1.9	3.2	37.4	77.3	125.6
MODELED RELEASE (CFS)	0.2	0.9	3.2	18.3	64.1	123.3
STORED VOLUME (AC–FT)	0.1	0.5	1.4	8.7	15.0	21.4

0 600 1200 2400
Scale in Feet

LEGEND

BASIN ID — SC3–77
DESIGN POINT — 87
REACH IDENTIFIER — RT–17A
PROPERTY BNDRY
BASIN BOUNDARY
FLOW DIRECTION
STORM SEWER
FULL SPECTRUM DETENTION POND — FSD16
DETENTION POND — PNDW3
SAND CREEK/EAST FORK BASIN PER DBPS
INTERBASIN TRANSFER FROM EAST FORK TO SAND CREEK PER DBPS (158.52 AC)

Verify

M&S CIVIL CONSULTANTS, INC.
20 BOULDER CRESCENT, SUITE 110
COLORADO SPRINGS, CO 80903
PHONE: 719.955.5485

2018 STERLING RANCH MDDP
PROPOSED HYDROLOGIC CONDITIONS MAP

PROJECT NO. 08-035	FILE: \dwg\Eng Exhibits\2018-MDDP-PROPCOND.dwg	
DESIGNED BY: JD	SCALE	DATE: 06-26-2018
DRAWN BY: JD	HORIZ: 1"=2400'	DM2
CHECKED BY: VAS	VERT: 1"=2400'	

File: Q:\09002A\Sterling Ranch District\dwg\Eng Exhibits\2018 MDDP\PROPCOND.dwg Plotstamp: 7/3/2018 11:10 AM

Sterling Ranch Master Development Plan
Sand Creek Basin - Future Conditions - Reach Data

Reach ID	Reach Length L1 (ft)	Reach Vert. Drop H1 (ft)	Reach Slope S1 %	Mannings N Value n	Reach Side Slope SS (H/V)	Bottom Width BW (ft)	Diameter D ft
RT-1	3975	100	2.5%	0.05	10	6	N/A
RT-2	4570	120	2.6%	0.05	10	6	N/A
RT-3	2360	65	2.8%	0.05	10	6	N/A
RT-4	2695	65	2.4%	0.05	10	6	N/A
RT-5	4100	92	2.2%	0.05	6	10	N/A
RT-6	3030	100	3.3%	0.05	10	6	N/A
RT-7	6145	122	2.0%	0.05	10	6	N/A
RT-8	2160	42	1.9%	0.05	6	15	N/A
RT-9A	1015	19	1.9%	0.05	6	30	N/A
RT-9B	1450	26	1.8%	0.05	6	30	N/A
RT-9C	1490	28	1.9%	0.05	6	30	N/A
RT-10A	1940	42	2.2%	0.013			5
RT-10B	1560	42	2.7%	0.013			5
RT-11A	1275	26	2.0%	0.05	6	30	N/A
RT-11B	2960	46	1.6%	0.05	6	30	N/A
RT-12A	2590	40	1.5%	0.05	6	40	
RT-12B	4200	66	1.6%	0.035	4	15	
RT-13	1550	20	1.3%	0.05	6	40	N/A
RT-14	1765	35	2.0%	0.05	6	40	N/A
RT-15A	900	24	2.7%	0.013			4
RT-15B	1450	30	2.1%	0.013			6
RT-16	1250	24	1.9%	0.013			3.5
RT-17A	5000	108	2.2%	0.04	4	4	N/A
RT-17B	3675	76	2.1%	0.013			4
RT-18	2500	41	1.6%	0.05	6	40	N/A
RT-19	1200	6	0.5%	0.013			6
RT-20	1480	22	1.5%	0.05	6	40	N/A

Model has been QC'd for timing.
Channel stabilization intended to
conicide with DBPS improvements.
provided in report (see discussion)

Provide velocities, recommended stabilized slope and number/type/size of drop structures.

Provide DBPS tables VIII

Sterling Ranch - East Fork Basin
Hydrologic Study - Future Conditions - Reach Data

Reach ID	Reach Length L1 (ft)	Reach Vert. Drop H1 (ft)	Reach Slope S1 %	Mannings N Value n	Reach Side Slope SS (H/V)	Bottom Width BW (ft)	Diameter D ft
RT-1E	300	6	2.0%	0.021	N/A	N/A	4
RT-2E	2000	40	2.0%	0.021	N/A	N/A	4
RT-3E	400	10	2.5%	0.021	N/A	N/A	4
RT-4E	3600	90	2.5%	0.021	N/A	N/A	4
RT-5E	1250	31	2.5%	0.021	N/A	N/A	5
RT-6E	1485	37	2.5%	0.021	N/A	N/A	4
RT-7E	1410	35	2.5%	0.021	N/A	N/A	6

refer to previous response

Provide velocities, recommended stabilized slope and number/type/size of drop structures.

Sterling Ranch MDDP
DRAINAGE REPORT DRAINAGE CALCULATIONS
(Pond Volume Calculation)

PndW3

Elevation	SF	CF	Storage AF	Storage Sum
0.00	0.00			0
2.00	67,474.00	67,474.00	1.55	1.55
4.00	150,180.00	217,654.00	5.00	6.55
6.00	166,246.00	316,426.00	7.26	13.81
8.00	182,942.00	349,188.00	8.02	21.83
10.00	200,393.00	383,335.00	8.80	30.63
12.00	218,500.00	418,893.00	9.62	40.24
14.00	322,218.00	540,718.00	12.41	52.66
16.00	413,841.00	736,059.00	16.90	69.55

Provide discharge at each stage.

provided in report (see discussion)

Total = 3,029,747 CF

Total = 69.6 Ac-ft

Calculated by: DLM

Date: 6/21/2016

Checked by:

?

removed

Wilson Company
PLD volume NEW INCLUDING EAST FORK.xlsx

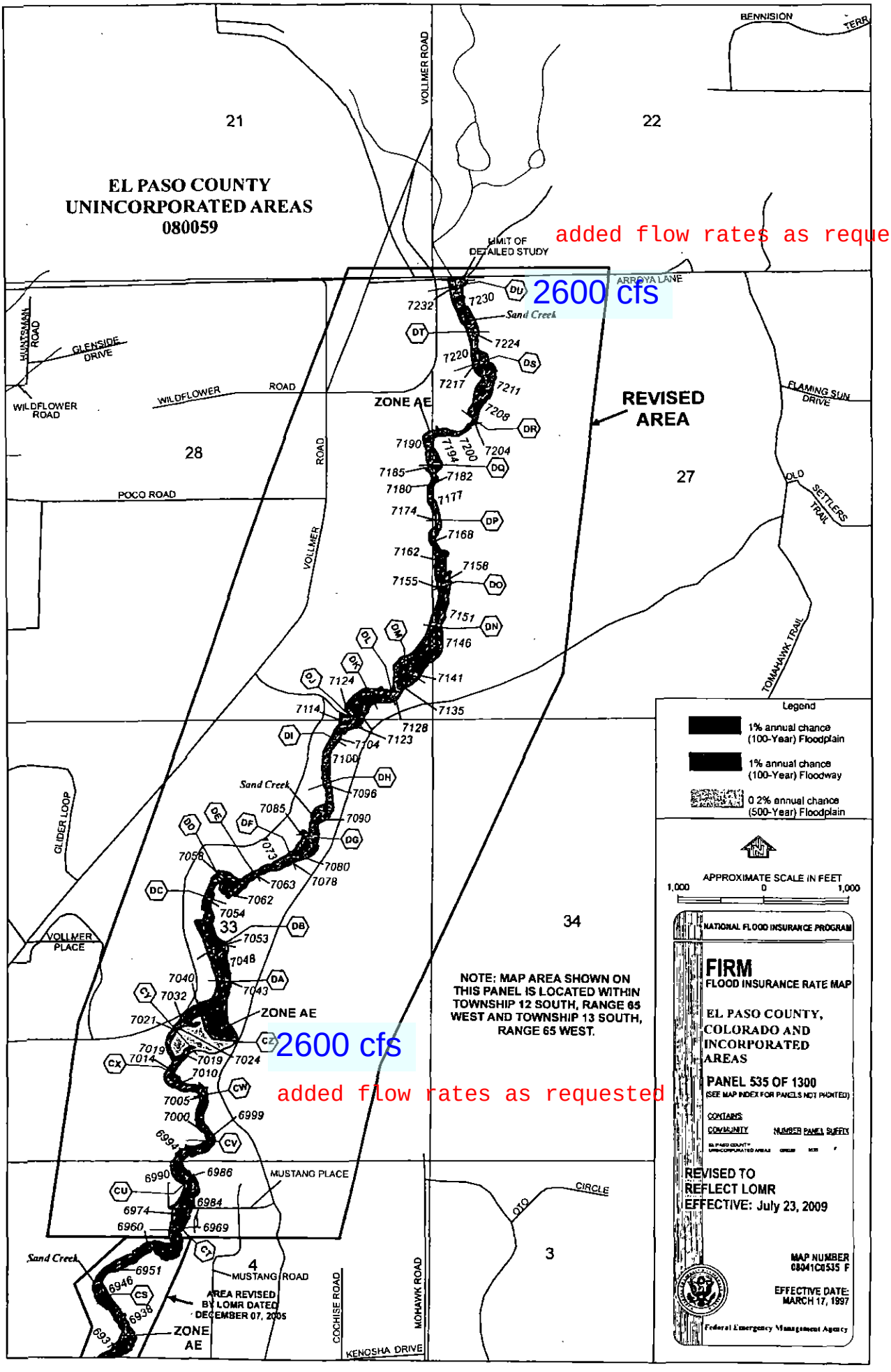
Sand Creek Channel Study
Hydrologic Study - Future Conditions
Water Quality Control Volume Sizing Worksheet

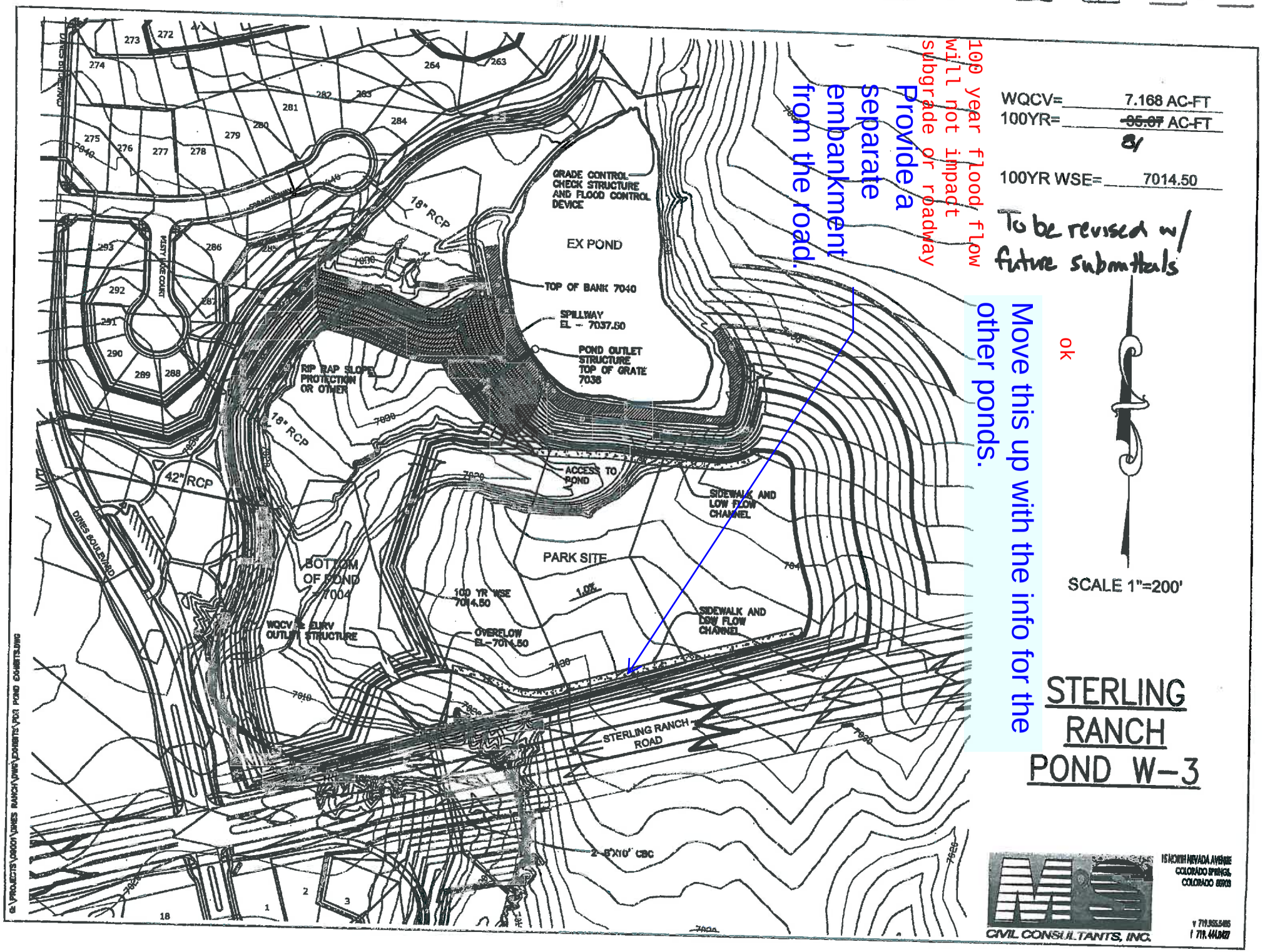
FSD9

CONTRUBUTING BASINS	ACREAGE AC	SOILS A%	SOILS B%	IMPERVIOUS %	SLOPE %
SC3-8	143.40	23	77	10	2.0
SC3-9	217.40	78	22	15	1.8
COMBINED ACREAGE	360.80				
COMB. % IMPERVIOUS				13%	
COMB. % A SOILS		56%			
COMB. % B SOILS			44%		
COMB. SLOPE					1.9%

What about old SC8 / SC6-0 area?

flows planned to be directed to pond 6


EL PASO COUNTY
UNINCORPORATED AREAS
080059
21
22
28
27
34
3
4
added flow rates as requested
2600 cfs
LIMIT OF DETAILED STUDY
ZONE AE
REVISED AREA
Sand Creek
VOLLMER ROAD
WILDFLOWER ROAD
POCO ROAD
MUSTANG PLACE
MUSTANG ROAD
COCHISE ROAD
MOHAWK ROAD
KENOSHA DRIVE
CIRCLE
OTO
ARROYA LANE
FLAMING SUN DRIVE
OLD SETTLERS TRAIL
TOMAHAWK TRAIL
GLIDER LOOP
VOLLMER PLACE
GLENSIDE DRIVE
HUNTSMAN ROAD
BENNISION TERR
AREA REVISED BY LOMR DATED DECEMBER 07, 2005
NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 12 SOUTH, RANGE 65 WEST AND TOWNSHIP 13 SOUTH, RANGE 65 WEST.
Legend
1% annual chance (100-Year) Floodplain
1% annual chance (100-Year) Floodway
0.2% annual chance (500-Year) Floodplain
APPROXIMATE SCALE IN FEET
1,000 0 1,000
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO AND INCORPORATED AREAS
PANEL 535 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)
CONTAINS
COMMUNITY NUMBER PANEL SUFFIX
REVISED TO REFLECT LOMR EFFECTIVE: July 23, 2009
MAP NUMBER 08041C0535 F
EFFECTIVE DATE: MARCH 17, 1997
Federal Emergency Management Agency


GRADE CONTROL CHECK STRUCTURE AND FLOOD CONTROL DEVICE
EX POND
TOP OF BANK 7040
SPILLWAY EL = 7037.50
POND OUTLET STRUCTURE TOP OF GRATE 7038
RIP RAP SLOPE PROTECTION OR OTHER
18" RCP
18" RCP
42" RCP
ACCESS TO POND
SIDEWALK AND LOW FLOW CHANNEL
PARK SITE
BOTTOM OF POND = 7004
100 YR WSE 7014.50
WQCV & EURV OUTLET STRUCTURE
OVERFLOW EL=7014.50
SIDEWALK AND LOW FLOW CHANNEL
STERLING RANCH ROAD
2-8'X10' CBC
DINES BOULEVARD
HAYRIDGE COURT
WQCV= 7.168 AC-FT
100YR= ~~85.87~~ AC-FT
8/
100YR WSE= 7014.50
To be revised w/ future submittals
ok
SCALE 1"=200'
100 year flood flow will not impact subgrade or roadway
Provide a separate embankment from the road.
Move this up with the info for the other ponds.
STERLING RANCH POND W-3
CIVIL CONSULTANTS, INC.
15 NORTH NEVADA AVENUE
COLORADO SPRINGS, COLORADO 80903
v 719.955.5485
f 719.444.0427

LAND USE LEGEND:

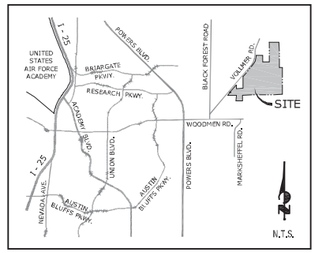
	44 AC. RESIDENTIAL: 0.2 DU/AC,	9 D.U.
	33 AC. RESIDENTIAL: 0.4 DU/AC,	13 D.U.
	35 AC. RESIDENTIAL: 1 DU/AC,	35 D.U.
	163 AC. RESIDENTIAL: 2 DU/AC,	326 D.U.
	475 AC. RESIDENTIAL: 3-5 DU/AC,	1,900 D.U.
	101 AC. RESIDENTIAL: 5-8 DU/AC,	606 D.U.
	257 AC. RESIDENTIAL: 5-8 DU/AC ACTIVE ADULT,	1,542 D.U.
	32 AC. RESIDENTIAL: 8-12 DU/AC,	320 D.U.
	41 AC. RESIDENTIAL: 12-20 DU/AC,	656 D.U.
	56 AC. COMMERCIAL	
	57 AC. ELEMENTARY / K-8 SCHOOL	
	18 AC. NEIGHBORHOOD PARK	
	30 AC. COMMUNITY PARK	
	57 AC. OPEN SPACE / PARK / GREENWAY	
	43 AC. OPEN SPACE / BUFFER	
	2 AC. UTILITY PARCEL	

TOTAL: 1444 AC. TOTAL: 5,407 D.U.

SYMBOL LEGEND:

- ROAD
- FULL MOVEMENT ACCESS POINT
- 100-YEAR FLOODPLAIN
- TRAIL
- BUFFER / OS TRAIL CORRIDOR / EASEMENT
- NEIGHBORHOOD PARK
- X,XXX' ACCES SPACING (FEET)

VICINITY MAP:



OWNER & DEVELOPER INFO:

MORLEY-BENTLEY INVESTMENTS, LLC.
20 BOULDER CRESCENT ST.
COLORADO SPRINGS, CO 80903
TEL: (719) 471-1742

NOTES:

1. MTCP, CPP, AND PROPOSED CLASSIFICATION AND ROW DATA IS FOUND ON PAGE 16 OF THE SKETCH PLAN REPORT.
2. NO SCHOOL SITES ARE SHOWN IN THE ACTIVE ADULT COMMUNITY DUE TO THE NATURE OF THE USE. IF THIS USE CHANGES, OR SCHOOL-AGE CHILDREN OCCUPY THESE UNITS, SCHOOL DEDICATION WILL BE MADE.

Sterling Ranch SKETCH PLAN

MORLEY-BENTLEY INVESTMENTS, LLC.

URBAN DESIGN
LAND PLANNING
& LANDSCAPE
ARCHITECTURE
NES
628 South Tejon Street
Colorado Springs, CO 80903
Tel 719.471.0073
Fax 719.471.0267

FIGURE NO. 8 PAGE 30

DATE: 05/15/2008

This isn't the latest version (Nov. 2008)

provided the correct sketch plan